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USER MANUAL

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1 INTRODUCTION

ARVOR is a subsurface profiling float developed jointly by IFREMER and MARTEC Group. Since January 1st, 2009 **nke** has integrated profiling floats activity and is now in charge of ARVOR manufacturing and development in industrial partnership with IFREMER.
ARVOR is the successor of PROVOR CTS3, from which it takes up most of the essential sub-assemblies.

The ARVOR float described in this manual is designed for the ARGO Program. This international program will be a major component of the Global Ocean Observing System (GOOS). An array of 3,000 free-drifting profiling floats is planned for deployment in 2004. These floats will measure the temperature and salinity of the upper 2,000 meters of the ocean, allowing continuous monitoring of the ocean's climate.

All Argo measurements will be relayed and made publicly available within hours after collection. The data will provide a quantitative description of the evolving state of the upper ocean and the patterns of ocean climate variability, including heat and freshwater storage and transport. It is expected that ARGO data will be used for initialization of ocean and coupled forecast models, and for dynamic model testing. A primary focus of Argo is seasonal to decadal climate variability and predictability.

After launch, ARVOR's mission consists of a repeating cycle of descent, submerged drift, ascent and data transmission. During these cycles, ARVOR dynamically controls its buoyancy with a hydraulic system. This hydraulic system adjusts the density of the float causing it to descend, ascend or hover at a constant depth in the ocean. The user selects the depth at which the system drifts between descent and ascent profiles. ARVOR continually samples the pressure at this drift depth and maintains that depth within approximately 30m.

After the submerged drift portion of a cycle, the float proceeds to the depth at which the ascending profile is to begin. The ascent profile starting depth (typically the ARGO-selected depth of 2,000m) is not necessarily the same as the drift depth.

During its mission, ARVOR collects measurements of three parameters - salinity, temperature and depth (CTD) - and saves them in its memory. These measurements can be made during the float descent (descent profile), during the submerged drift period (Lagrangian operation) and during the ascent (ascent profile).

After each ascent, ARVOR transmits its saved data to the satellites of the Argos system. The volume of data is reduced using a compression algorithm in order to reduce the time needed for transmission. The Argos system calculates the float's position during its stay on the sea surface.

In 2013, nke developed new firmware evolutions for sampling capacity increasing, reliability improvement during all float life phases, and introduce possibility to program 2 Mission schemes (2 cycle period, with associated Parking and Profile Depth) (see figure 5 on page 26 for more details about cycle possibilities).

By this way, ARVOR float can realized specific cycle program closed to deployment area, and then switch to a classical ARGO program.

This manual describes the ARVOR float, how to use it and safety precautions to be observed during handling.

Please read this manual carefully to ensure that ARVOR functions as intended.

Overview of the present manual's contents:

- Chapter 2 contains the instructions necessary for the personnel in charge of the deployment
- Chapter 3 describes the components of ARVOR; it is intended for those who want a more in-depth understanding of ARVOR
- Chapter 4 describes the mission of ARVOR
- Chapter 5 describes the various parameters
- Chapter 6 describes the various ARGOS messages
- Chapter 7 presents the technical specifications
- Chapter 8 provides explanations about the operation of ARVOR
- Chapter 9 specifies the elements of the constraints limited to the transport of Lithium batteries.

2 OPERATING INSTRUCTIONS

The following instructions tell you how to handle, configure, test and launch the ARVOR float. Please read these instructions carefully and follow them closely to ensure your ARVOR float functions as intended.

2.1 Handling Precautions

ARVOR is designed to withstand submersion at great depths for long periods of time (up to five years). This remarkable specification in oceanographic instrumentation is possible thanks to the protection of the casing by an anti-corrosion coating. This coating is sensitive to impact. Damage to the coating can accelerate the corrosion process.

NOTE: Take precautions to preserve the anti-corrosion coating during handling. Remove the float from its packing only when absolutely necessary.

NOTE: Regulations state that ARVOR must not be switched on during transport.

2.2 Acceptance Tests

Immediately upon receipt of the ARVOR float, you should test it to confirm that it is complete, correctly configured and has not been damaged in shipment. If your ARVOR float fails any of the following tests, you should contact **nke instrumentation**.

2.2.1 Inventory

The following items should be supplied with your ARVOR float:

- The present user manual
- A test sheet
- Quickstart & Deployment checklist

NOTE: Disassembly of the float voids the warranty.

Check that all of the above items are present. If any are missing, contact **nke-instrumentation**.

2.2.2 Physical Inspection

Upon the opening of the transport casing, visually inspect the float's general condition: Inspect the transport container for dents, damage, signs of impact or other signs that the float has been mishandled during shipping.

Inspect the CTD sensor, antenna, hull, housing around the lower bladder for dents or any other signs of damage

NOTE: Ensure the magnet is in place against the hull (on ON/OFF position), meaning that float is switched OFF.

2.3 Default Parameters

Notwithstanding special instructions given to NKE during the ARVOR preparation stage, the following set of parameters is applied: **section 5 ARVOR PARAMeterS**.

If these parameters are not appropriate, the user can change them himself by following the instructions.

2.3.1 ARGO Identification

The user is responsible for contacting the AIC in order to obtain the WMO number which will identify the ARVOR's mission

2.3.2 Decoding

The CORIOLIS project team (IFREMER) is able to assist the teams that use ARVOR for data processing.

Nke can provide light PC software for manual data decoding. Contact **nke-instrumentation**.

2.4 Launching

Following is what you should do to launch the ARVOR float.

2.4.1 Test the Float and arm the mission

Before you take ARVOR on deck for deployment, we recommend that you repeat all of the tests described in **section 2.5.8 "Display Sensor Data"**. This will ensure that the float is functioning and configured correctly and maximize the probability of success of your experiment.

IMPORTANT: Before launching the float, you must arm the mission by issuing the !AR command:

!AR 1

ARVOR will execute auto-test (see section 2.5.8 page 16 for description) and respond :

<AR ON>

Put the magnet on the float (ON/OFF position).

NOTE: ***Once the mission is armed, the next time you will attempt to communicate with the float upon magnet removal, you need to establish Bluetooth connection (see section 2.5.2 page 10) and press "ENTER" within 50 seconds after 5 pump activations in order to get the prompt].***

2.4.2 Remove protective plugs and magnet

The pump system of the CTD sensor is sealed by 3 protective plugs. Remove these plugs from the sensor before launching.

CTD Sensor

Protective plugs (1 red and 2 white plugs)

Remove the magnet located near the top of the float (Figure 2 – General view of ARVOR float). Retain the magnet for future use in case the float is recovered.

ARVOR is now ready for launch.

To confirm that the magnet has been removed and that the float is ready for launch, 5 seconds after magnet removal, ARVOR starts 5 valves actions and 5 hydraulic pump activations followed by seabird pump activation. If you have water in the CTD, this water go out by the holes where were the protective plugs. Then float wait 50 sec (delay for user to connect by Bluetooth if needed) before performing an auto-test. If Auto-test is OK (up to several minutes), float will **activate buzzer for 30 minutes period**. This signal is the required condition for float deployment.

NOTE: ***Once the magnet has been removed, the ARVOR float performs an initial test. Ensure that the CTD pump starts as explained above before placing the float in the water.***

Auto-test delay buzzer activation(for 30 minutes)can take several minutes.

If your do not hear the buzzer activation after a few minutes, and you do not see the water level change in conductivity cell, replace the magnet, connect the PC, and conduct the tests described in **section 2.5 page 10.**
If these tests fail, contact **nke** technical support.

2.4.3 Deployment checklist

Test	Description	Expected Result	Result
Check before deployment			
1	Visual inspection	No scratch, good general state	☐ OK
2	Magnet Position	Magnet placed on ON/OFF position	☐ OK
3	Remove CTD plugs (1 red & 2 white plugs)	Plugs removed (see section 2.4.2 page 7)	☐ OK
4	Distilled Water in conductivity cell	Introduce distilled water in conductivity cell (enable CTD pump check on test 8 & 9)	☐ OK
Check during deployment (Float must be on VERTICAL position)			
5 T0	Magnet removal	Magnet removed from ON/OFF position	☐ OK
6 T0+5-15s	5 slow Ev activations	5 Ev activations heard (5-15 sec after magnet removal)	☐ OK
7	5 pump activations	5 pump activations heard	☐ OK
8	CTD pump	Water level change in CTD water circuit	☐ OK
	One Minute Delay before mission begins	During 50 sec, user can connect to float with Bluetooth to enter in dialog mode. After this delay, floats begins mission (no more dialog possible with float, until new reset)	☐ OK
9 T0+100s	Full Auto-Test	Full auto-test (int. vacuum, batteries, sensors test, short pump & Ev activation, 3 ARGOS tx spaced by 7 seconds) **3 ARGOS transmission** (Check with ARGOS Beeper. See annex C for beeper positioning)	☐ OK
10 T0+140s	**Buzzer activation**	**Buzzer activates for 30 minutes**	☐ **OK**
11	Delay before mission	Wait for “Delay Before Mission” Minutes (“MC6”)	☐ OK
12	Satellite Transmission	ARGOS transmission during “AC6”	☐ OK
Deployment			
13	Deployment	Deployment system in place	☐ OK
14	Float drift	Float drift at surface	☐ OK

Table 1 - Deployment Checklist

If **step 10** is not reached, place magnet on ON/OFF position and try again from beginning (Step 5)

Do not DEPLOY after 3 unsuccessfull tries !

2.4.4 Launch the Float

NOTE: Keep the float in its protective packaging for as long as possible to guard against any nicks and scratches that could occur during handling. Handle the float carefully, using soft, non-abrasive materials only. Do not lay the float on the deployment vessel's unprotected deck. Use cardboard or cloth to protect it.

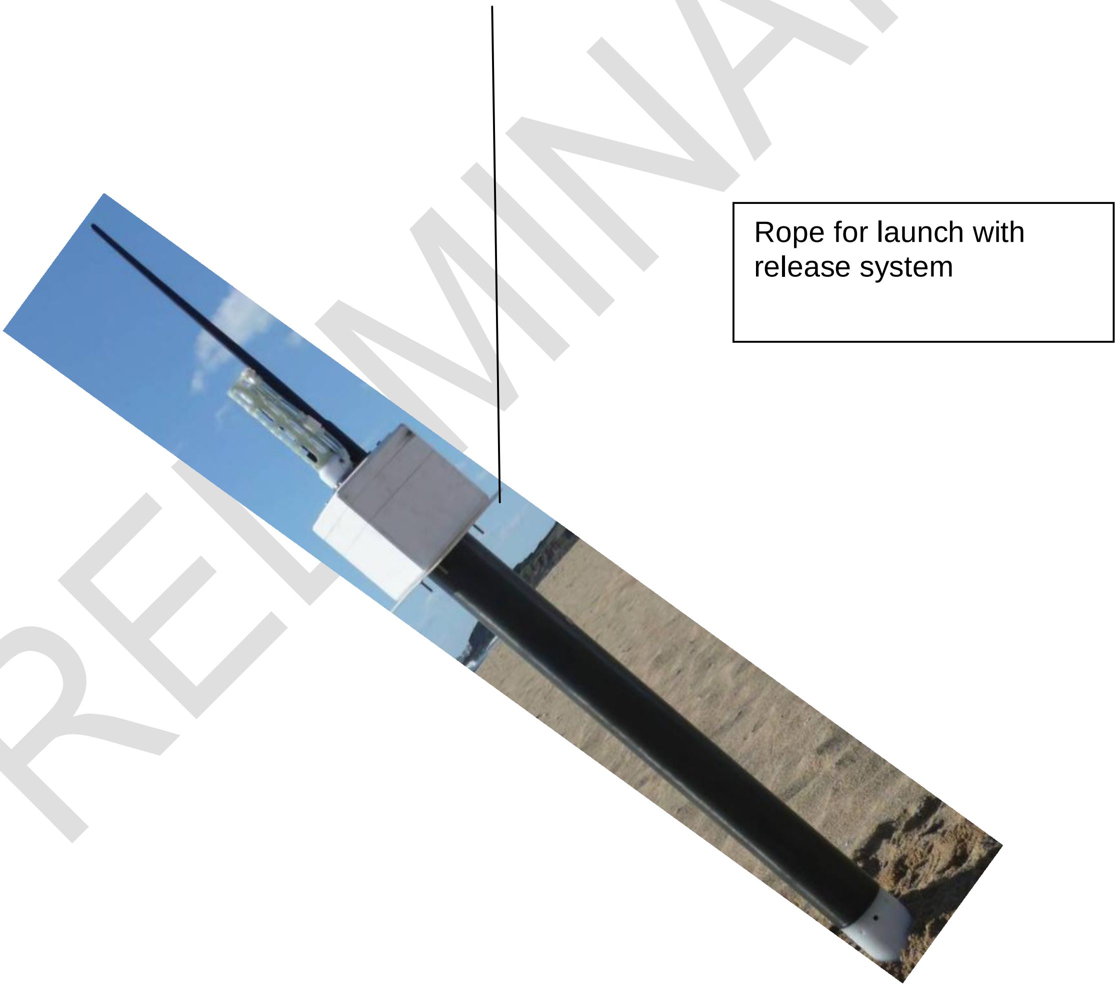
2.4.4.1 By hand

ARVOR can be launched by hand from the deck from a height of 2 meters maximum.

2.4.4.2 Using a rope

The damping disk is already fastened on the tube (under the buoyancy foam).
It is possible to use the holes in the damping disk in order to handle and secure the float during deployment.

Put the rope in the hole according to the following photo :



After the launch, you may decide to wait alongside the float until it starts its descent, but this can take up to 4 hours depending on the float's buoyancy when it is placed in water and also on Initial ARGOS transmission duration (given by Argos Command AC(6) Argos transmission test time).

2.5 Checks prior to deployment

2.5.1 Necessary Equipment

The equipment required to check that ARVOR is functioning correctly and to prepare it for the mission are:

(1) A PC.
The most convenient way of communicating with ARVOR is with a PC in terminal emulation mode. Among other advantages, this allows storage of configuration parameters and commands. You can use any standard desktop or laptop computer. The PC must be equipped with a serial port (usually called COM1 or COM2).

(2) VT52 or VT100 terminal emulation software.
The Hyper Terminal emulation software can be used.

(3) A Bluetooth Dongle with drivers installed on the PC (BELKIN class 2 model is recommended).

(4) An accurate time source.
This could be a wristwatch, a GPS receiver or the PC's internal clock. Some users use a GPS receiver connected to the PC to adjust the clock.

(5) An Argos test set.
This device receives Argos messages directly from the transmitter for test purposes (Goniometer, RMD02 receiver).

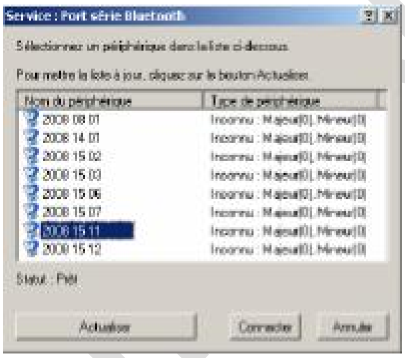
2.5.2 Connecting the PC

Make sure you check the following points before attempting a connection:

- ✓ Bluetooth key connected to the PC with the drivers installed
- ✓ Magnet present at the Bluetooth's power supply ILS. See Figure 2 – General view of ARVOR float
- ✓ Start Hyperterminal after checking on which COM port the Bluetooth key is installed by going to: Control Panel->System-> Click on Hardware tab->Device Manager as shown in the figure below:

- ✓ On the PC, run the following commands as shown in the figure below
- ✓ Right click on the Bluetooth logo in the bottom right corner of the Desktop
- ✓ Select Quick Connect, Bluetooth Serial Port, then click on other devices

A window appears as shown in the figure below:

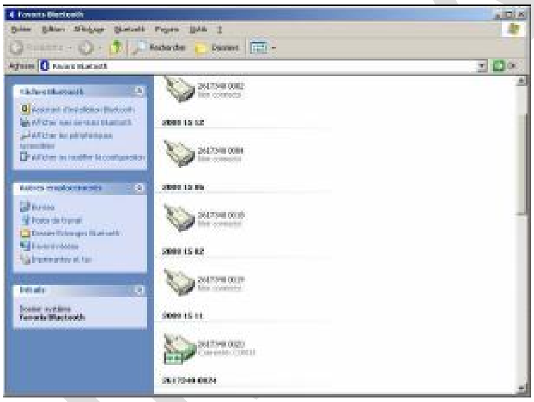


- ✓ Click on Refresh
- ✓ Check that the Bluetooth number is present on the traceability label (see Figure 2 – General view of ARVOR float
- ✓ There are two ways of establishing the connection:
- ✓ Either select the number shown and press Connect
- ✓ Or come back to the previous step and instead of selecting “other devices”, select the number shown
- ✓ When the connection is made, a dialog box appears as shown in the figure above:

Double click on it and a window appears as shown below:

- ✓ Enter the security code “0000”
- ✓ You can now check the connection by double clicking on the Bluetooth logo in bottom right corner of the Desktop

- ✓ The “Bluetooth favourites” window appears:



Use your PC's terminal emulation software to configure the selected serial port for:

- 9,600 baud
- 8 data bits
- 1 stop bit
- Parity: none
- Full duplex
- No flow control

2.5.3 Example of Bluetooth dongle tested by NKE

USB Bluetooth™ – 100 meters Part# F8T012fr Made By belkin

2.5.4 How to Send Commands

You must communicate with ARVOR to verify or change its configuration parameters, to read data from the float, or to test the float's functions. You perform these verifications/changes by sending commands, and by observing the float's response to those commands. Compose commands by typing characters on the keyboard of your PC, and send them to ARVOR by pressing the Enter key.
In the following descriptions of commands we will use the general syntax:

- Keystrokes entered by the user are written in **bold**.
- Replies received from the float are in normal font.
- Commands entered by the user end with the Enter key.

Complete description and list of user command can be read using the command **?HE**

The software version can be viewed using the **?VL** command
ARVOR will respond:
<VL 5605Y0x (where Y indicates major software revision and x indicates minor software revision)
<VC -ARGOS->
<VC -ARVOR->
<Firmware make ID : 0>

The float's serial number can be viewed using the **?NS** command
ARVOR will respond:
<NS 14001> (year 14, identification 1)

2.5.5 How to Read and change Parameter Values

Read the values of "mission commands" by sending the MC command. Do this by typing the characters **?MC** in response to ARVOR's ']' prompt character then confirm the command by pressing the Enter key. It should look like this:

?MC

ARVOR will respond:

<MC0 300>
<MC1 300>
<MC2 240>
<MC3 240>
<MC4 2>
<MC5 6>
<MC6 0>
<MC7 0>
<MC8 12>
<MC9 10>
<MC10 1000>
<MC11 2000>
<MC12 1000>
<MC13 2000>
<MC14 10>
<MC15 200>
<MC16 1>
<MC17 10>
<MC18 25>
<MC19 60>
<MC20 0>
<MC21 0>

<MC22 50>
<MC23 1>
<MC24 0>

As you can see, the responses are of the form:

- MC parameter number, value.

You can also read the values of the parameters individually using the command : **?MC X**

where **X** identifies the parameter. Each parameter is identified by a parameter number corresponding to a parameter name. They are summarised for reference in **section 5.1 & 5.2 page 26**

By the same way, you can read ARGOS commands with the following command **?AC**

ARVOR will respond :

<AC0 40>
<AC1 100>
<AC2 25>
<AC3 1>
<AC4 1>
<AC5 000000>
<AC6 180>
<AC7 530>

Command no.	Name	Default Value	Units
Mission Commands			
MC0	Total Number of Cycles	300	Whole number
MC1	Number of cycle with "Cycle Period 1"	300	
MC2	Cycle Period 1	240	Hours
MC3	Cycle Period 2	240	Hours
MC4	Reference Day	2	Number of days
MC5	Estimated time at the surface	6	Hours
MC6	Delay Before Mission	0	Minutes
MC7	Descent Sampling Period	0	Seconds
MC8	Drift Sampling Period	12	Hours
MC9	Ascent Sampling Period	10	Seconds
MC10	Drift Depth for "MC1" first cycles	1000	dBar
MC11	Profile Depth for "MC1" first cycles	2000	dBar
MC12	Drift Depth after "MC1" cycles are done	1000	dBar
MC13	Profile Depth after "MC1" cycles are done	2000	dBar
MC14	Threshold surface/Intermediate Pressure	10	dBar
MC15	Threshold Intermediate /bottom Pressure	200	dBar
MC16	Thickness of the surface slices	1	dBar
MC17	Thickness of the intermediate slices	10	dBar
MC18	Thickness of the bottom slices	25	dBar
MC19	Iridium End Of life period (UNUSED)	60	Minutes
MC20	2nd Iridium Session Wait Period (UNUSED)	0	Minutes
MC21	Grounding mode (0= Shift, 1 : Stay grounded)	0	
MC22	Grounding switch pressure	50	dBar
MC23	Delay at surface if grounding at surface	1	Minutes
MC24	Optode type (0: none, 1 : 4330, 2 : 3830)	0	

Argos Commands			
AC0	Argos Transmission Period	40	Seconds
AC1	Argos Transmission Period at Life Expiry	100	Seconds
AC2	Retransmission	25	Whole number
AC3	Argos Transmission Duration	1	Hours
AC4	Number of Argos addresses	1	Whole number
AC5	Argos ID 1[0 .. 6]	0000000	Hexa
	Argos ID 2[0 .. 6]	0000000	Hexa
	Argos ID 3[0 .. 6]	0000000	Hexa
	Argos ID 4[0 .. 6]	0000000	Hexa
AC6	Argos transmission test time upon launch, before surfacing adjustment.	180	Minutes
AC7	Offset on transmission frequency in hundreds of Hertz, here: 401.653 000 MHz	530	Hundreds of Hertz

Table 2 - Mission & Argos commands

For example, to verify the value of the ascent sampling period, send the command:

? MC 9

ARVOR will respond:

<MC9   10>

where 10 is the sampling period in ascent.

The commands for **changing** the values of the mission parameters are of the form :

!MC X Y

where X identifies the parameter and Y provides its new value.

For example, to change the number of cycles with "period 1" to 150, send the command :

!MC 1 150

ARVOR will respond:

<MC1   150>

NOTE: ARVOR will always respond by confirming the present value of the parameter. This is true even if your attempt to change the parameter's value has been unsuccessful, so you should observe carefully how ARVOR responds to your commands.

2.5.6 How to Check and change the Time

Connect the PC to the float using the BT connection (see **section 2.5.2 page 10**). Ask ARVOR to display the time stored in its internal clock by sending the command:

? TI

(Do this by typing the characters **? TI** followed by the Enter key). ARVOR will respond:

01/03/14, 14h 41m 00s

]

The date and time are in the format DD/MM/YY HHh MMm SSs

You can set the time on the float's internal clock by sending the command:

!TI DD MM YY hh mm ss

For example, if you send the command:

!TI 01 03 14 14 30 00

ARVOR will respond:

01/03/14, 14h 30m 00s

]

2.5.7 Configuration Check

The float has been programmed at the factory. The objective of this portion of the acceptance test is to verify the float's configuration parameters.

Connect the PC to the float (see **section 2.5.2 page 10**). Send the MC command, as explained in **section 2.5.5. page 13**, to verify that ARVOR's parameters have been set correctly.

All command list is given in Section "USER COMMANDS" page 30

2.5.8 Functional Tests

Connect the PC to the float (see **section 2.5.2**).

NOTE: The hydraulic components will function correctly only if the float is in a vertical position with the antenna up.

Orient the float vertically, and support it to prevent it from falling over during the performance of the functional tests.

ARVOR has several commands that allow you to test its various functions. Float can indicate all available commands by sending command

?HE

Float will answer with commands list and description

2.5.8.1 Auto-test

Before sending float auto-test, place the float on vertical position.

Float can realize 2 kind of auto-tests. The "standard one" and the "full auto-test". These auto-test are used by float to check all internal components.

Standard auto-test can be done by sending command :

!C 0

Float will respond :

CPU:OK ARGOS TX (3 TX, spaced by 7 seconds) INT. VACUUM:OK (600) BAT:OK (10900) CTD:OK PRESSURE SENSOR :OK (No Optode, type = 0) FLASH:OK (calc:A20C read:A20C)]

During auto-test, float will make 3 argos transmissions, will test "internal vacuum", CTD sensor (CTD mode and pressure request), parameters integrity and firmware integrity (checksum).

Full auto-test is identical to standard auto-test, with buzzer activation once test is finished and successful.

Full auto-test can be done by sending command **!C 1**

2.5.8.2 Display of technological parameters

This command is used to display :

- Internal vacuum (V)
  This vacuum is drawn on the float as one of the final steps of assembly. It should be between 500 and 700 mbar absolute. 600 mbar (@20°C) is recommended.
- Battery voltage (B)
  Normal values for a new battery are 10.8 volts (see test sheets for limits).
  Send the command :

?VB
ARVOR will respond:

<B:109 V:605 (A=2.000 B=-200.000)> meaning 10.9V for battery voltage and 605 mBar as internal vacuum

A & B coefficients are specific to float and vary from one to another.

A & B coefficients value can be checked on document FIT provided with float

2.5.8.3 Display Sensor Data

This command is used to display:

- External pressure (P)
- Temperature (T)
- Salinity (S)

Send the command:

?S
ARVOR will respond:
<S: 10cBars 24561mdc 12mPSU>
As this sensor is in open air, only the temperature data should be regarded as accurate.

2.5.8.4 Test Hydraulic Pump

To activate the pump for one second, send the command :

!P 100
Listen for the pump running for one second (unit: centiseconds).

2.5.8.5 Test Hydraulic Valve

To activate the valve for one second, send the command:

!E 100
Listen for the actuation of the valve (unit: centiseconds).

2.5.8.6 Test Argos Subsystem

To test the Argos transmitter, send the command :

!SE

The float will respond for the number of hours programmed ("AC3"). Put the magnet back in place to stop the transmission.

This command will cause ARVOR to transmit several messages. They are technical messages, the format of which is described in **section 6 page 32**.

Use your Argos test set to receive the message. The message content is not meaningful, this is a test of the transmission only, but the test messages do have valid Argos IDs and CRCs.

2.5.8.7 Check armed mode

To check if armed mode is ON or OFF, send the command :
?AR
Float will respond :
<AR ON> if armed mode is ON or <AR OFF> if armed mode is OFF. Float will execute an auto-test in order to check that all sub-assemblies are ready for deployment.
Armed mode set "ON" (=1) means that float is ready for deployment. Armed mode set to OFF (=0) means that float enters in "user-dialog mode" each time float is powered ON.

You have now completed the functional tests. Ensure the magnet is in place on the ON/OFF position (see Figure 1 - Magnet positions).

Before deployment, armed mode must absolutely be set to ON (=1)!

If armed mode is ON, next time float is powered ON, after a delay of 50 seconds, float begin a new mission and it won't be possible to send command to float anymore. During the 50s delay, user can enter in "dialog mode" by connecting on bluetooth and type on "ENTER" character until float send prompt character (**"]"**).

Armed mode is set in factory on request. This information (AR state) can also be verify by reading FIT file delivered with float.

You have now completed the functional tests. Ensure the magnet is in place on the ON/OFF position (see Figure 1 - Magnet positions).

3 GENERAL DESCRIPTION OF ARVOR FLOAT

3.1 ARVOR

The main developments of ARVOR compared to the PROVOR CTS-3 float are mainly:

- ✓ Embedded software,
- ✓ Electronics,
- ✓ Battery pack,
- ✓ Float casing, frame
- ✓ MMI link
- ✓

3.1.1 Electronics

A new CPU board has been developed to take in account the obsolescence of components of the CTS-3 profiler.

3.1.2 Embedded software

The CPU board is equipped with a new embedded software taking in account supplementary inputs and possibilities required by the ARVOR float.

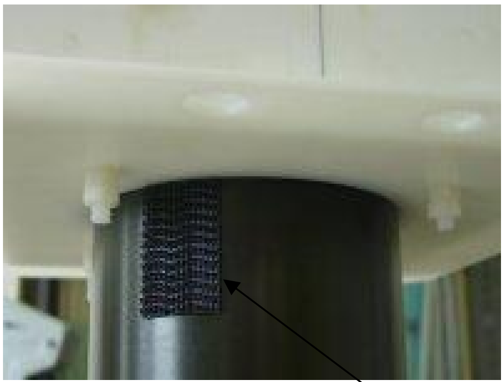
3.2 Hull

The ARVOR float is encased in an aluminium cylinder measuring 11.3 cm in diameter and 100 cm in height. A surface finish prolongs life by impeding corrosion. The float is carefully designed to have a compressibility that is lower than that of seawater, essential for stable operation at ocean depths where pressures reach 200 atmospheres.

The influence of surface swell upon the instrument's heave is attenuated by a Buoyancy foam pad positioned around the upper part of the hull.

3.3 Magnet Positions

ON/OFF Magnet Position (Float is Powered ON if magnet removed)



BLUETOOTH Magnet Position (Bluetooth Module Power ON if magnet installed). Do not install at deployment, for Programmation and dialog with float only

Figure 1 - Magnet positions

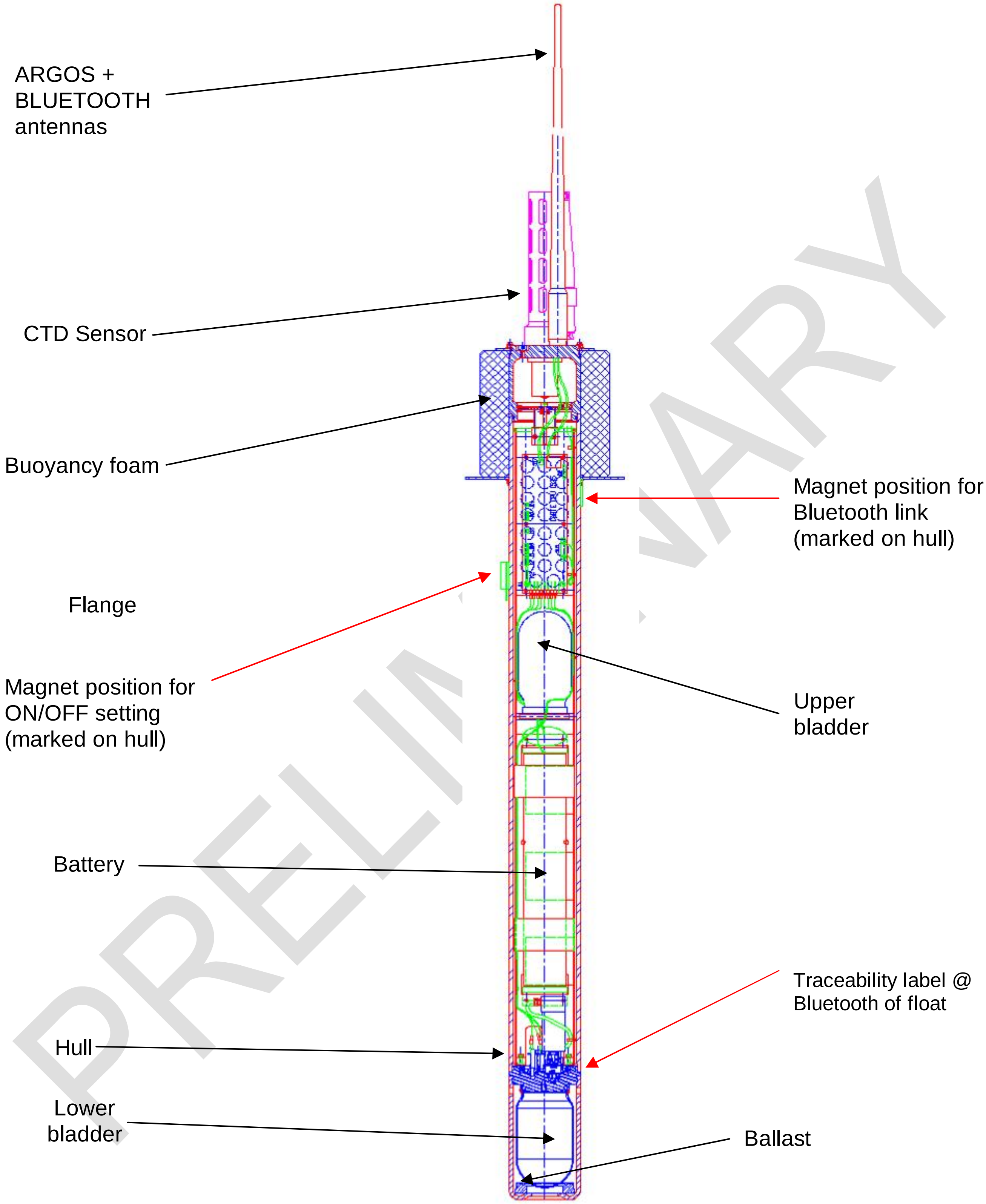


Figure 2 – General view of ARVOR float

3.4 Density Control System

Descent and ascent depend upon buoyancy. ARVOR is balanced when its density is equal to that of the level of surrounding water. The float has a fixed mass. A precision hydraulic system is used to adjust its volume. This system inflates or deflates an external bladder by exchanging oil with an internal reservoir. This exchange is performed by a hydraulic system comprising a high-pressure pump and a solenoid valve.

The interested reader is referred to a more detailed description of the operation of ARVOR's density control system in **section 8 page 50.**

3.5 Sensors

ARVOR is equipped with precision instruments for measuring :

- pressure, temperature and salinity with the SEABIRD SBE41CP CTD sensor. Specifications of the sensor are provided in **section 7 page 49.**

3.6 Argos Transmitter

While the float is at the surface, the Argos transmitter sends stored data to the satellites of the Argos system (see **sections 6. page 32 and 6.2. page 33**). The transmitter has a unique ID assigned by Argos. This ID identifies the individual float. The Argos antenna is mounted on the top end of the ARVOR float and must be above the sea surface in order for transmissions to reach the satellites.

3.7 CPU Board

This board contains a micro-controller (or CPU) that controls ARVOR. Its functions include maintenance of the calendar and internal clock, supervision of the depth cycling process, data processing and activation and control of the hydraulics.

This board allows communication with the outside world for the purpose of testing and programming.

3.8 Battery

A battery of lithium thionyl chloride cells supplies the energy required to operate ARVOR.

3.9 MMI link

The User link is made via Bluetooth (radiofrequency link)

3.10 Firmware evolution in 2013

ARVOR firmware has been modified in 2013 with several objectives. Main objectives were :

- Better resistance to deployment conditions (Auto-test improvement, ...)
- Deployment procedure simplification (with use of Buzzer)
- Possibility to program 2 Mission schemes (2 cycle period, with associated Parking and Profile Depth) (see figure 5 on page 26 for more details about cycle possibility)
- Increase technical return from float (Creation of 2nd technical message and parameter message)
- Sampling capability increasing
- User interface simplification

4 THE LIFE OF AN ARVOR FLOAT

The life of an ARVOR float is divided into 4 phases: Storage/Transport, Deployment, Mission, & Life Expiry.

(1) Storage/Transport
During this phase, the float, packed in its transport case, awaits deployment. The electronic components are dormant, and float's buoyancy control functions are completely shut down. This is the appropriate status for both transport and storage.

(2) Deployment
The float is removed from its protective packaging, configured, tested and launched at sea.

(3) Mission
The mission begins with the launching of the float. During the Mission, ARVOR conducts a pre-programmed number of cycles of descent, submerged drift, ascent and data transmission. During these cycles it collects CTD data, computes data, and transmits it to the Argos satellite system.

(4) Life Expiry
Life Expiry begins automatically upon completion of the pre-programmed number of cycles. During Life Expiry, the float, drifting on the sea surface, periodically transmits messages until the battery is depleted. Reception of these messages makes it possible to locate the float, to follow its movements and, if desired, to recover it. ARVOR floats are designed to be expendable, so recovery is not part of its normal life cycle.

If the battery is depleted before completion of the pre-programmed number of cycles, ARVOR will probably remain submerged and cannot be located nor recovered.

4.1 The Mission - Overview

We call "Mission" the period between the moment when the float is launched at the experiment zone and the moment when the data transmission relating to the final depth cycle is completed.

During the Mission, ARVOR conducts ascent and descent profiles, separated by periods of Argos transmitting and drifting at a predetermined depth. ARVOR can collect data during the descent, submerged drift, or ascent portions of the cycle, and transmits the collected data during the surface drift period at the end of each cycle. One cycle is shown in the figure below.

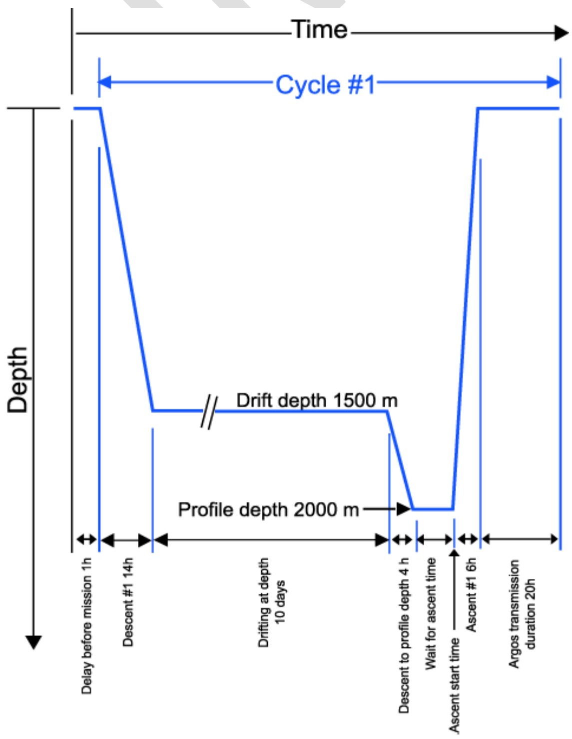


Figure 3 Schematic representation of a ARVOR's depth-cycle during the Mission

(1) Delay Before Mission

To prevent ARVOR from trying to sink before it is in the water, the float waits for this time before starting its descent. This happens only before the first cycle; it is not repeated at each cycle.

(2) ARGOS Preliminary Transmissions

To test ARGOS transmitter, before descent phase, float will perform ARGOS transmission during a period defined by user with "AC6" parameter (expressed in minutes). Argos messages are send each "AC1" seconds (end of life period). Float send technical ARGOS messages (see **section 6.** for more details).

(3) "Pressure sensor offset" reset

Resetoffset command is send to SBE41-CP sensor -> Sample pressure for 1 minute. Store measured pressure as new pressure offset. Maximum allowed offset is 2 percent of full scale.

(4) Buoyancy reduction

Float is deployed with full external bladder to get a maximal buoyancy. To reach a neutral buoyancy position before descending, float needs to transfer oil inside float. For the 2 first cycles this phase can take up to one hour and a half (by opening electro-valve several times with one minute for pressure monitoring between activations). At following cycles, float memorized necessary global electro-valve opening time (precedent cycle) and reduce this global duration by reducing the time between valve activations to one second instead of 1 minute.

(5) Descent

The float descends at an average speed of 3 cm/sec. During descent, which typically lasts a few hours, ARVOR can detect possible grounding on a high portion of the seabed and can move away from such places (see **section 4.3. page 23** for more details on grounding). ARVOR can collect CTD measurements during descent or ascent.

In order to respect the requirement of the ARGO program, the first cycle of the mission always collect CTD measurements during the descent at the sampling period of 10 seconds (even if "MC7" is set to 0).

(6) Drifting at Depth

During the drift period, ARVOR drifts underwater at a user-selected drift depth, typically 1,000m to 2,000m below the sea surface. The drift period is user-selectable and can last from a few days to several weeks, but is typically 10 days. The float automatically adjusts its buoyancy if it drifts from the selected depth by more than 50 dBar over a 60-minute period. ARVOR can collect CTD measurements at user-selected intervals during this drift period if the user selects this option.

(7) Descent to Profile Depth

The user may select a starting depth for the ascent profile that is deeper than the drift depth. If this is the case, ARVOR must first descend to the profile depth before beginning the ascent profile.

ARVOR can detect a possible grounding during this descent and take corrective action (as described in **section 4.3. page 23)**

(8) Wait for Ascent Time

The user can program several floats to conduct profiles simultaneously. This makes it possible to use several ARVOR floats in a network of synoptic measurements, even though the instruments are not all deployed at the same time. If this is the case, it may be necessary for ARVOR to standby at the profile starting depth while awaiting the scheduled ascent time.

(9) Ascent

Ascent lasts a few hours, during which time ARVOR ascends to the sea surface at an average speed of 10cm/sec. ARVOR can collect CTD measurements during descent or ascent.

(10) Transmission

At the end of each cycle, the float finds sufficient buoyancy to ensure Argos transmission quality. ARVOR remains at the sea surface transmitting the data collected during the preceding descent-drift- ascent portion of the cycle.

The duration of the Argos transmission period and the interval between transmissions can both be set by the user. The choices depend upon the quantity of data that ARVOR must transmit and the latitude of the float. In order to conserve battery life and minimize the chance of collision with shipping, the duration of this transmission period should be no longer than necessary. A transmission duration of 10 hours is usually more than adequate to ensure reception of all data collected during the cycle. The Argos satellite system receives the data and calculates the float's location during this transmission period.

4.2 Descent

While the float is still at the sea surface ARVOR measures and records its pressure sensor offset. This offset is used to correct all pressure measurements. The offset is transmitted in a technical message (see **section 6.)** for a description of technical messages format). Descent takes the float from the sea surface to the drift depth. Initially, in order to avoid possible collisions with ships, ARVOR's objective is to lose buoyancy in the shortest possible time. It does this by opening the solenoid valve for a time period that is initially long, but decreases as the float approaches its target depth.

If the user chooses, ARVOR will collect CTD measurements during descent and/or during ascent. The interval between CTD measurements is user-programmable.

4.3 Grounding

ARVOR monitors itself for possible grounding on the seabed. During descent to drift depth, if the pressure remains unchanged for too long, ARVOR enters a correction mode. The user selects one of two available modes during Mission programming before launch (mission command "MC21") :

- Grounding Mode = 0: The pre-programmed drift depth is disregarded. The pressure at the time of grounding minus an offset (100 dBar typical, see "MC22" value) is taken as the new value for the drift pressure. The float adjusts its buoyancy to reach this new parking drift depth. The drift depth reverts to its programmed value for subsequent cycles.
  If the grounded pressure is lower than a programmed threshold (200 dBar), the float remains on the seabed until the next programmed ascent time.
- Grounding Mode = 1: the float remains where it is until the next scheduled ascent time. The pressure measured at grounding becomes the profile start pressure for the cycle in progress. The profile start pressure reverts to its programmed value for subsequent cycles.

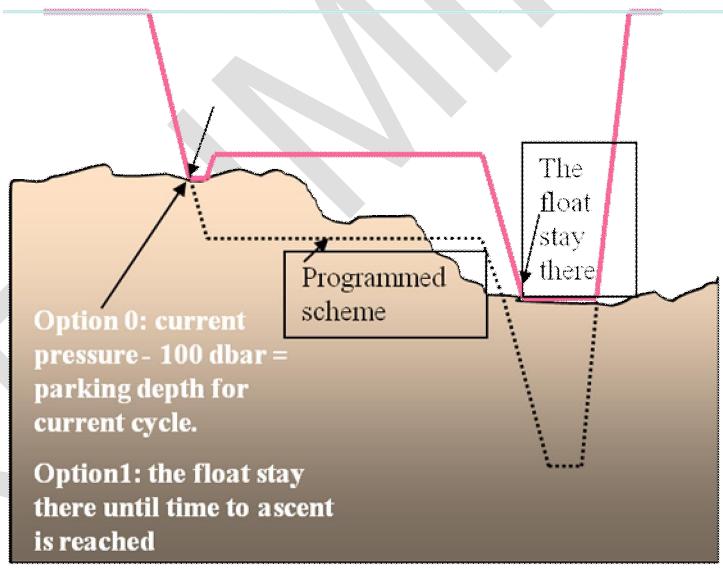


Figure 4 - Schematic representation of a ARVOR's behaviour in case of grounding

4.4 Submerged Drift

While ARVOR is drifting at drift depth, it checks the external pressure every 30 minutes to determine whether there is need either for depth adjustment or for an emergency ascent.

If the measured pressure differs from the drift depth pressure by more than a specified tolerance, and this difference is maintained, ARVOR adjusts its buoyancy to return to the drift depth.

If the pressure increases by an amount that exceeds a factory-set danger threshold, ARVOR immediately ascends to the sea surface.

If the user chooses, ARVOR will collect CTD measurements at user-selected intervals during submerged drift.

4.5 Ascent

If the chosen ascent profile starting pressure is higher than the drift pressure, the float must first descend to reach the profile starting pressure.

If grounding is detected while ARVOR is descending to the profile starting pressure, the present pressure is substituted for the profile starting pressure. This substitution is only for the cycle in progress; the profile starting pressure reverts to its pre-programmed value for subsequent cycles.

Once the profile starting pressure has been reached, the float waits for the programmed time to begin the ascent. If this time is reached before the float has arrived at the profile starting pressure, the ascent starts immediately.

ARVOR ascends by repeated use of the pump. When the pressure change between two successive measurements is less than 10 dBar, the pump is activated for a pre-set time period. In this way, the pump performs minimum work at high pressure, which ensures minimum electrical energy consumption. The average speed of ascent is approximately 10cm/sec. For a 2,000m profile, the ascent would therefore last 6 hours.

When the pressure drops below 10 dBar (signifying completion of ascent), ARVOR waits 10 minutes and then activates the pump in order to empty the reservoir and achieve maximum buoyancy. If the user chooses, ARVOR will collect CTD measurements during descent and/or ascent. CTD measurements begin at the profile start time and stop 10 minutes after the float rises above the 10 dBar isobar in its approach to the sea surface. The interval between CTD measurements is user-programmable. For example, during a profile beginning at 2,000 m with a 10 sec sampling period, 2,200 CTD measurements will be collected.

4.6 Transmission

The data transmission process takes into account the limitations of the Argos data collection system, including:

- the flight frequency of the satellites above the experiment zone;
- the uncertainty of the float's antenna emerging in rough seas;
- radio propagation uncertainties due to weather conditions, and;
- the satellites' operational status.

ARVOR creates transmission messages from the stored “Treated data” (see 6.3 CTD Data Treatment details page 34 for treatment details). The transmission of all messages is repeated until the total duration of transmissions exceeds the user-programmed minimum duration (“AC3”). The interval between transmissions is also user-programmable (“AC0”).

Please refer to **section 6. Page 32** for a detailed description of the transmitted message formats.

5 ARVOR PARAMETERS

ARVOR's configuration is determined by the values of its mission and Argos commands defined below. Instructions on how to read and change the values of these parameters are provided in section 2.5.5. page 13 The following table summarizes all parameter names, ranges and default values (Software YLA5605Y0x).

Command no.	Name	Def Value	Units
Mission Commands			
MC0	Total Number of Cycles	**300**	**Whole number**
MC1	Number of cycle with “Cycle Period 1”	**300**	**Number of days**
MC2	Cycle Period 1	**240**	**Hours**
MC3	Cycle Period 2	**240**	**Hours**
MC4	Reference Day	**2**	**Number of days**
MC5	Estimated time at the surface	**6**	**Hours**
MC6	Delay Before Mission	**0**	**Minutes**
MC7	Descent Sampling Period	**0**	**Seconds**
MC8	Drift Sampling Period	**12**	**Hours**
MC9	Ascent Sampling Period	**10**	**Seconds**
MC10	Drift Depth for “MC1” first cycles	**1000**	**dBar**
MC11	Profile Depth for “MC1” first cycles	**2000**	**dBar**
MC12	Drift Depth after “MC1” cycles are done	**1000**	**dBar**
MC13	Profile Depth after “MC1” cycles are done	**2000**	**dBar**
MC14	Threshold surface/Intermediate Pressure	**10**	**dBar**
MC15	Threshold Intermediate /bottom Pressure	**200**	**dBar**
MC16	Thickness of the surface slices	**1**	**dBar**
MC17	Thickness of the intermediate slices	**10**	**dBar**
MC18	Thickness of the bottom slices	**25**	**dBar**
MC19	Iridium End Of life period (UNUSED)	**60**	**Minutes**
MC20	2nd Iridium Session Wait Period (UNUSED)	**0**	**Minutes**
MC21	Grounding mode (0= Shift, 1 : Stay grounded)	**0**	
MC22	Grouding switch pressure	**50**	**dBar**
MC23	Delay at surface if grounding at surface	**1**	**Minutes**
MC24	Optode type (0: none, 1 : 4330, 2 : 3830)	**1**	
Argos Commands			
AC0	Argos Transmission Period	**40**	**Seconds**
AC1	Argos Transmission Period at Life Expiry	**100**	**Seconds**
AC2	Retransmission	**25**	**Whole number**
AC3	Argos Transmission Duration	**1**	**Hours**
AC4	Number of Argos addresses	**1**	**Whole number**
AC5	Argos ID 1[0 .. 6]	**0000000**	**Hexa**
	Argos ID 2[0 .. 6]	**0000000**	**Hexa**
	Argos ID 3[0 .. 6]	**0000000**	**Hexa**
	Argos ID 4[0 .. 6]	**0000000**	**Hexa**
AC6	Argos transmission test time upon launch, before surfacing adjustment.	**180**	**Minutes**
AC7	Offset on transmission frequency in hundreds of Hertz, here: 401.6**53 0**00 MHz	**530**	**Hundreds of Hertz**

Table 3 - Summary of ARVOR user-programmable parameters

5.1 Mission Commands

MC(0) Total Number of Cycles

This is the total number of cycles of descent, submerged drift, ascent and transmission that ARVOR perform. The mission ends and ARVOR enters Life Expiry mode when this number of cycles has been completed.
The capacity of ARVOR's batteries is sufficient for at least 250 cycles. If you wish to recover ARVOR at the end of the mission, you must set the number of cycles at less than 250 to ensure there is sufficient battery capacity remaining to allow ARVOR to return to the sea surface and enter Life Expiry.
Under favourable conditions, the battery capacity may exceed 250 cycles. If you do not plan to recover the ARVOR float, you may choose to set the number of cycles to 250 to ensure that ARVOR completes the maximum number of cycles possible.

MC(1) Number of cycle with “Cycle Period 1”

The first “MC1” cycle parameters are provided by parameters “MC2” (duration of the cycle), “MC10” (Drift Parking Depth) and “MC11” (Profile Depth). The following cycles use the “MC3, “MC12” and “MC13” parameters respectively.

MC(2) Cycle Period 1 (hours) *

The duration of the first “MC1” cycle of the mission. ARVOR waits submerged at the drift depth for as long as necessary to make the cycle the selected duration.

MC(3) Cycle Period 2 (hours) *

The duration of the cycles that follow the first “MC1” ones. ARVOR waits submerged at the drift depth for as long as necessary to make the cycle the selected duration. This cycle period is applied to float once “MC1” cycles have been done up to total number of cycle (given by “MC0”). If previous cycle period (“MC2”) was not modulo 24hours and “MC3” is modulo 24hours, next hour at surface (for following cycles) will be programmed with “MC5”.

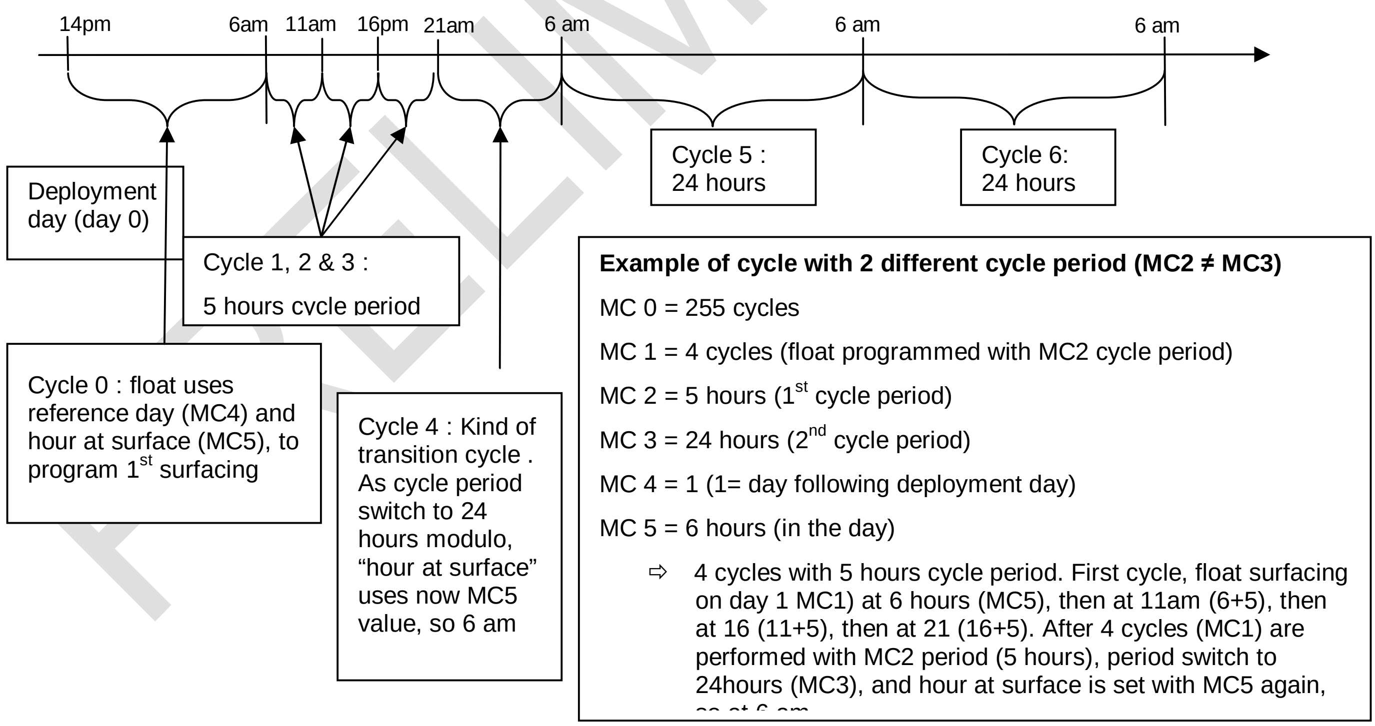


Figure 5 : Cycle period description

MC(4) Reference Day (number of days)

Allows you to configure a group of floats so that they all conduct their profiles at the same time, even if they are not deployed at the same day. The parameter defines a particular day on which the first profile is to be made. When the float's internal clock's day number equals the reference day, it will conduct its first profile. The float's internal clock day number is set to zero when the mission starts. When setting the reference day, it is recommended to allow enough time between the deployment and reach of profiling depth. Using a reference day of at least 2 will ensure the first profile is complete.

MC(5) Estimated Time on Surface (hours)

Estimated time float must reach surface.

MC(6) Delay Before Mission (minutes)

To prevent ARVOR from trying to sink while still on deck, the float waits for this time before commanding the buoyancy engine to start the descent. After disconnection of the PC, followed by removal of the magnet, ARVOR will wait for this delay before beginning the descent. The delay is measured after the first start of the pump which confirms the removal of the magnet (see **section 2.4.1 page 7**) and before the start of the descent.

MC(7) Descent Sampling Period (seconds)

The time interval between successive CTD measurements during descent.
If this parameter is set to 0 seconds, no profile will be carried out during the descent phase. Nevertheless, due to the ARGO requirements, the first descent profile of the mission is automatically done even if the parameter is equal to 0 (in that case, the descent profile is done with a 10 seconds sampling period).

MC(8) Drift Sampling Period (hours)

The time interval between successive CTD measurements during ARVOR's stay at the drift depth.

MC(9) Ascent Sampling Period (seconds)

The time interval between successive CTD measurements (raw data) during ascent.

MC(10) Drift Depth used during "MC1" first cycle (dBar) **

The depth at which ARVOR drifts after completion of a descent while awaiting the time scheduled for the beginning of the next ascent.

MC(11) Profile Depth used during "MC1" first cycles (dBar) **

Depth at which profiling begins. If ARVOR is drifting at some shallower depth, it will first descend to the profile depth before starting the ascent profile.

MC(12) Drift Depth used with cycle period MC2 (dBar) **

The depth at which ARVOR drifts after completion of a descent while awaiting the time scheduled for the beginning of the next ascent.

MC(13) Profile Depth used with cycle period MC2 (dBar) **

Depth at which profiling begins if in an ascending profile. If ARVOR is drifting at some shallower depth, it will first descend to the profile depth before starting the ascent profile.

MC(14) Threshold surface/Intermediate Pressure (dBar) **

The isobar that divides surface depths from intermediate depths for the purpose of data reduction.

MC(15) Threshold Intermediate / Bottom Pressure (dBar) **

The isobar that divides Intermediate depths from shallow depths for the purpose of data reduction.

MC(16) Thickness of the surface slices (dBar) **

Thickness of the slices for shallow depths (algorithm of data reduction).

MC(17) Thickness of the intermediate slices (dBar) **

Thickness of the slices for shallow depths (algorithm of data reduction).

MC(18) Thickness of the bottom slices (dBar) **

Thickness of the slices for deep depths (algorithm of data reduction).

MC(19) End of life period (hours) (Iridium floats only. Unused for ARGOS floats)

Transmission period (in hours) once float is in "end of life mode" (all programmed cycles have been reached. Float send Technical SBD message.

MC(20) 2nd Iridium Session Wait Period (min) (Iridium floats only. Unused for ARGOS floats)

At beginning of cycle, if this parameter is different of zero, 2 SBD sessions will occur. This enable to check if a change on mission or technical parameter has been correctly treated by float and if new parameters are effective for next cycle. After the 1st transmission, float will wait for MC20 minutes before proceeding to 2nd transmission.

MC(21) Grounding mode

MC21 = 0 means shift, MC21 = 1, means float stay grounded. See section 4.3 Grounding page 23, for more details about grounding strategy

MC(22) Grounding switch pressure

In case of grounding during descent to parking depth, when MC21=0 float will reduce target pressure from MC22 dBar.

MC(23) Delay in case of grounding at surface (minutes) (UNUSED)

MC(24) Optode Type

Set Optode type mounted on float, 0 : none (value for standard CTD floats), 1 : Aanderaa 4330, 2 : Aanderaa 3830

***** Cycle period can be set to inferior value than 24H. In that case, float will wait hour at surface for 1st cycle, and then will realize cycles every cycle period.

Example : cycle period is 8H, and hour at surface is 14h ("MC5") on day 1 (given by "MC4"). After deployment, at 1st cycle, float will be at surface at "MC5" hour, on day "MC4". Then, float will cycle every 8 hours.

In our example, float is deployed on 20/12/2013. Float will be at surface at 14:00 pm on 21/12/2013 for 1st cycle, then, at surface on 21/12/2013 at 22:00 pm, then , on 22/12/2013 at 6:00 am, ...

Cycle period must be in compliance with parking depth, profile depth, average descent and average ascent speed. Average descent speed is 27 mm/sec, and ascent speed is 90 mm/sec.

So, float cannot realize cycle at 2000 dBar every 12 hours for example.

****** ARVOR can transmit up to 2015 samples per cycle. Theoretical number of samples to be acquired can be estimated based on different threshold between 3 zones and on slices thickness.

5.2 Argos Commands

AC(0) Argos Transmission Period (seconds)
The time interval between successive Argos transmissions. If you use a short transmission period, Argos messages will be sent more frequently, improving the chances of reception. However, a shorter period also increases the fees charged to you by Argos. You must request the period that you want from Argos, and then you must use the value that they assign.

AC(1) Argos Transmission Period at Life Expiry (seconds)
The time interval between successive Argos transmissions while in End Of Life Mode. During this mode the float transmits only technical messages.

AC(2) Retransmission (*)
Desired number of retransmissions of the N ARGOS messages needed to transmit the data collected during the cycle. N may vary from one cycle to another. The effective number of retransmission also depends on "AC3" parameter.

AC(3) Argos Transmission Duration (hours) (*)
The time that ARVOR will remain on the surface transmitting its data at the end of each cycle. At lower latitudes you may wish to increase the value of this parameter to increase the probability of reception of all of your data.

AC(4) Number of Argos addresses
The number of addresses for the Argos transmitter. Up to 4 identification numbers are available. Argos transmission period between each Argos messages is divided by the Number of ARGOS ID.

AC(5) Argos ID
The identification number for the Argos transmitter. It is a 7-character hexadecimal number. This parameter must be set to the value provided by Argos. It is always possible to use an old Argos ID onto 5-character hexadecimal number. Then, the two last digits must be set to 00.

AC(6) Argos transmission test time upon launch, before surfacing adjustment.

AC(7) Transmission frequency
This is the offset, in hundreds of Hertz, of the ARGOS transmission frequency.
Ex.: 530 gives a transmission frequency of 401.6**53 0**000 MHz
This value is added to the frequency 401.6000 MHz

(*) Real ARGOS transmission duration at surface will be set like this :
MAX ("AC3", N*"AC0"*"AC2")

5.3 User Commands

User commands can be request to float with command :

?HE

Float will answer will available command list

Command	Rôle
!C x	Float complete auto-test. X = 0 or 1. Is X=1, a complete auto-test is done. If x=0, buzzer won't be activated
?CK	Firmware checksum check
!SE	Initiate Argos transmission session (duration specified by AC3)
!MC x y	Set value y for "mission command" x
?MC	Screen all mission commands
?MC x	Screen mission command x
!TC x y *	Set value y for "technical parameter" x
?TC *	Screen all technical commands
?TC x *	Screen technical command x
!AC x y	Set value y for "Argos command" x
?AC	Screen all Argos commands
?AC x	Screen Argos command x
!SH x	Activate (x=1) or de-activate (x=0) Show mode **(MUST BE OFF FOR DEPLOYMENT)**
?SH	Request show mode state
!TI dd mm yy hh mn ss	Set date and time to dd/mm/yy hh:mn:ss
?TI	Request float's internal date and time
?DH	Read all hydraulic data (pump and electrovalve activations) acquired during last mission
?DT	Read all Treated Data acquired during last mission
?DB	Read all Raw Data acquired during last mission
?SP	Read all Data (Treated & Raw CTD data, hydraulic data)
!E x	Activate electrovalve for x cs (ctrl-c to stop)
!P x **	Activate pump for x cs (ctrl-c to stop)
?S	CTD sensor acquisition
?FP	Fast Pressure request (Pressure measurement only)
?VB	Request internal vacuum and battery voltage (in decivolt and millibars)
!V	Float measure Internal vaccum and refresh value every 5 seconds
!AR x ***	Arm float (x=1) or deactivate arm mode (x=0) **MUST BE ON FOR DEPLOYMENT**

?AR	Request “armed mode” state
!RP	Parameters are transfered from EEPROM memory to RAM memory
!TB x	Activate buzzer for x seconds. To stop buzzer, send command !TB 0
?VL	Request software version
?NS	Request float’s serial number
!K x	Command to activate or deactivate read/Write access for technical parameters. X value is communicated to users upon request to nke
?RE	Read the 30 last reset date and time = each time float is powered ON
!PB	Request Battery Voltage with hydraulic pump active
?RO	SBE Pressure sensor last resetoffset value(deciBars)
!RO	SBE Pressure sensor resetoffset operation (take one minute)
!CU	Program SBE41 Cut-Off Pressure value according to technical command
!TR	SBE41 transparent dialog mode
?HE	Help command. Float will screen all available user commands

Table 4 - User command list

* : protected command (need !K x to unlock)
** : Float is delivered with hydraulic pump priming (fill in with oil). Pump must not be activated for long period as external bladder is already full

*** : As Armed Mode command is sent to float, float performs auto-test, and fill in external bladder, by activate hydraulic pump. Floats can pump up to several minutes depending on external bladder initial state.

6 ARGOS FORMATS

6.1 ARGOS Reminder

6.1.1 Reminder on ARGOS principle

ARGOS system is used to locate any mobile (ocean or meteorological buoy, animal, fishing vessel, etc.) carrying an ARGOS transmitter to within 300 meters and better and to collect data from sensors connected to the transmitter.

CLS is the worldwide operator of ARGOS satellites systems. From this system, CLS supplies platform location and scientific data collection.

The working principle of the ARGOS system is the following:

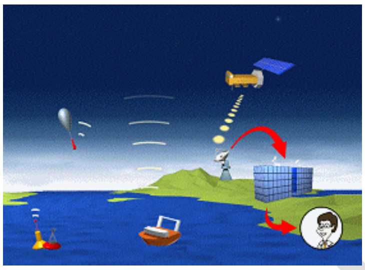


Figure 6 - ARGOS principle

(1) ARGOS transmitters automatically send messages that are received by satellites in low-earth orbit.
(2) Satellites relay messages to ground stations.
(3) Ground stations forward messages to processing centers. These centers calculate the transmitter locations and process any sensor data.
(4) The user access its results from its closest processing center.

6.1.2 Reminder on ARGOS Facilities

Figure 7 - ARGOS worldwide facilities

Five interlinked processing centers and 18 receiving stations worldwide provide continuous location and data collection service, and access to results.

For more information see Argos User's Manual (http://www.argos-system.org/manual/).

6.2 Overview

The data transmission process begins as soon as an ascent profile is completed. It starts with reduction of the data. ARVOR then formats and transmits the message. The reduction of data processing consists in storing the significant points of the CTD triplets arithmetic mean with the layer format (see chapter 6.3 CTD Data Treatment details for more detail about treatment)

For a given descent-drift-ascent-transmit cycle, the transmission of all of the data will usually require several messages of the same type.

To improve the probability of reception, data are transmitted several times. The number of repetitions depends upon the quantity of data to be transmitted, the transmission period and the programmed minimum transmission duration (see page 29 for details about Argos duration period). Messages are sent in a random sequence in order to minimize the chance of accidental synchronization of one message with some form of transmission interference.

To provide the reception of a continuous profile, messages contain one CTD triplet in two. This allows reconstruction of the profile when a message is lost. Example :

Message N: { triplet 1 ; triplet 3 ; triplet 5 ; triplet 7 ; triplet 9 ;.. triplet 21}

Message N+1 { triplet 2 ; triplet 4 ; triplet 6 ; triplet 8 ;... triplet 22 }.

CTD Data are interleaved, except for submerged drift CTD messages.

The content of the Argos messages consists of a preamble of 28 bits, followed by:

- the 20-bit Argos PTT identification number;
- the 8-bit Argos PTT identification complement;
- the data frame, consisting of 31 words of 8 bits (248 bits).

6 types of messages are generated according to the content of the data frame:

- Type 0000: 1st Technical message
- Type 0001: 2nd Technical message
- Type 0010: Parameter message
- Type 0100: Descent profile CTD message
- Type 0101: Submerged drift CTD message
- Type 0110: Ascent profile CTD message

The three types of CTD messages all contain recorded physical measurements. The technical messages contain data regarding the configuration and functioning of the float and its buoyancy control mechanism. The parameter message contains the current values of the float parameters.

The message type is formed from bits 1 to 4 of the data frame. The formatting of the data frame for each message type is described in the following pages.

The three types of CTD messages are built with CTD data compression, to reduce the total number of messages to transmit one complete profile. See chapter 6.4 CTD Data compression principle on page 36 for more details about compression principle.

After deployment during a user-parametric period ("AC6"), the float will transmit ARGOS message type 0, 1 & 2, as CTD measurements are not yet collected.

6.3 CTD Data Treatment details

Before transmission, all data have to be treated. Depending on sampling period, number of acquired raw data per profile could be too high for good transmission. So raw data are treated with following strategy : Operation to convert raw data (CTD samples) to “treated data” (CTD data to transmit) consist in 2 successive operations to raw data : **Decimation & averaging** depending on **zone & Slice thickness**

6.3.1 *Zone & Slice thickness*

User can define 3 zones with Threshold & Specific Slice Thickness (Mission commands).

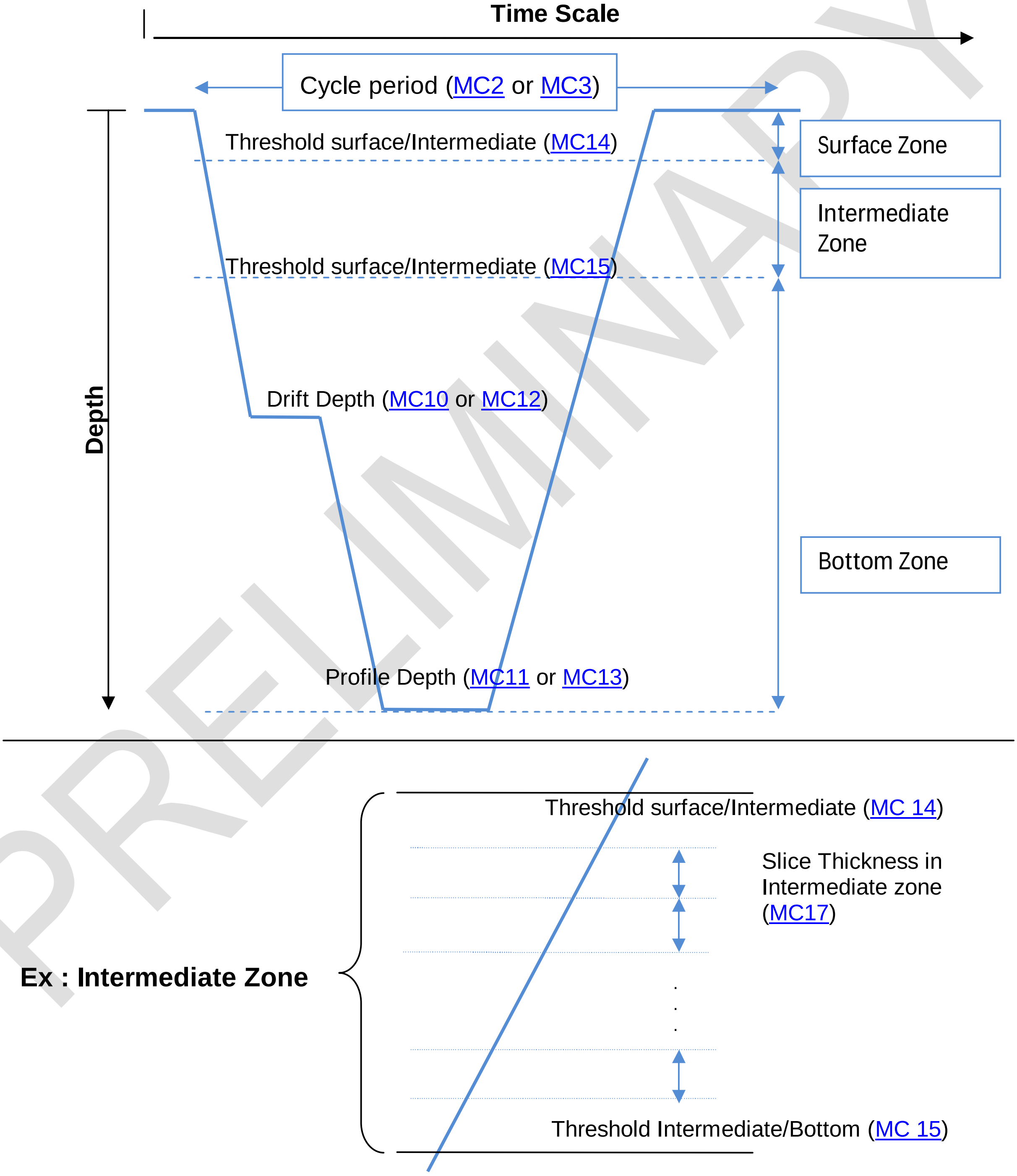


Figure 8- Zone & Slice thickness description

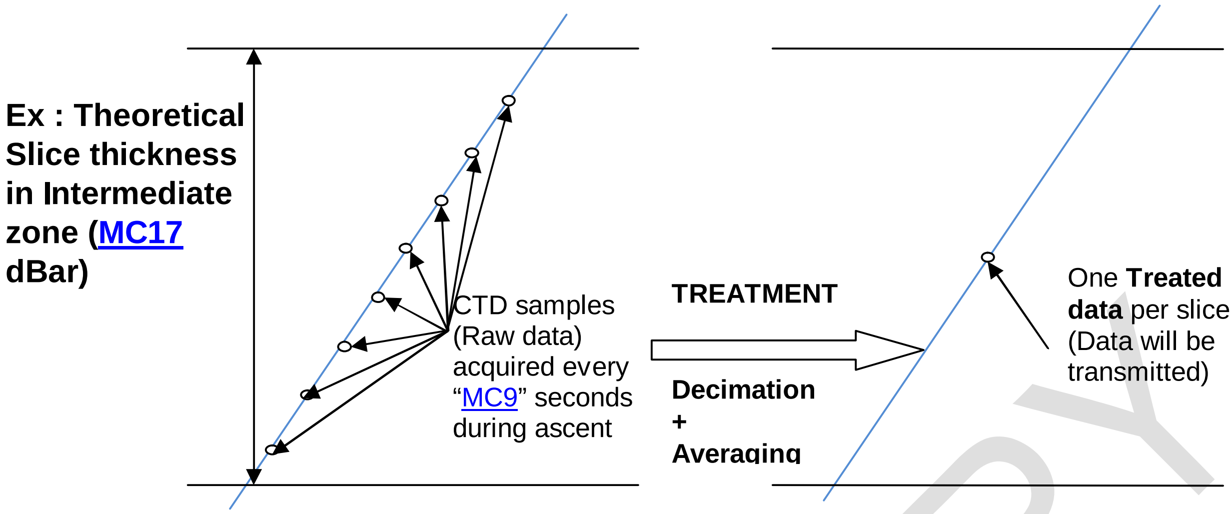


Figure 9 - Treatment description

6.3.2 Decimation

All raw data included in one theoretical CTD slice (defined with mission command depending on zone threshold and slice thickness in each zone) are filtered before proceed to averaging operation. Filter condition is that CTD samples must have 0.5 deciBar pressure variation (in the appropriate direction) with last kept CTD sample to be preserved.

Example : 5 dBar slice thickness in bottom zone (defined with "MC17") from 20 to 15 dBar.

CTD sample rank	CTD sample Pressure (raw data) in theoretical slice	CTD sample temperature	CTD sample salinity	Last previous kept sample pressure	Pressure difference with previous sample	Keep after decimation
0	19.9 dBar	17.312	33900	-	-	Yes (1st sample in slice)
1	19.3 dBar	17.314	33901	19.9	19.9–19.3 = **0.6**	Yes
2	18.9 dBar	17.317	33903	19.3	19.3–18.9 = 0.4	No
3	18.6 dBar	17.319	33904	19.3	19.3–18.6 = **0.7**	Yes
4	18.1 dBar	17.320	33905	18.6	18.6–18.1 = **0.5**	Yes
5	17.5 dBar	17.320	33906	18.1	18.1–17.5 = **0.6**	Yes
6	17.1 dBar	17.322	33907	17.5	17.5–17.1 = 0.4	No
7	16.5 dBar	17.329	33909	17.5	17.5–16.5 = **1.0**	Yes
8	16.1 dBar	17.338	33910	16.5	16.5–16.1 = 0.4	No
9	15.6 dBar	17.351	33910	16.5	16.5–15.6 = **0.9**	Yes
10	15.1 dBar	17.361	33913	15.6	15.6–15.1 = **0.5**	Yes

Table 5 - Decimation example

6.3.3 Averaging

All CTD samples kept after decimation are averaged according to slice thickness (zone and thickness) to create a “Treated Data”. All the treated Data will be transmit by ARGOS.

In our example, following sample pressure will be averaged :

19.9, 19.3, 18.6, 18.1, 17.5, 16.5, 15.6 & 15.1

CTD pressure for treated data is : 18.1375 dBar

Transmitted pressure will be **18 dBar**.

- CTD temperature sample will be averaged :

17.312, 17.314, 17.319, 17.320, 17.320, 17.329, 17.351, 17.361

CTD temperature for this treated data is : 17.3285 °C

Transmitted pressure will be **17.328 °C**.

- CTD salinity sample will be averaged :

33900, 33901, 33904, 33905, 33906, 33909, 33910, 33913

CTD temperature for this treated data is : 33906 mPSU

Transmitted pressure will be **33906 mPSU**.

6.4 CTD Data compression principle

Example for Ascent Profile CTD message (ARGOS Message coding method)

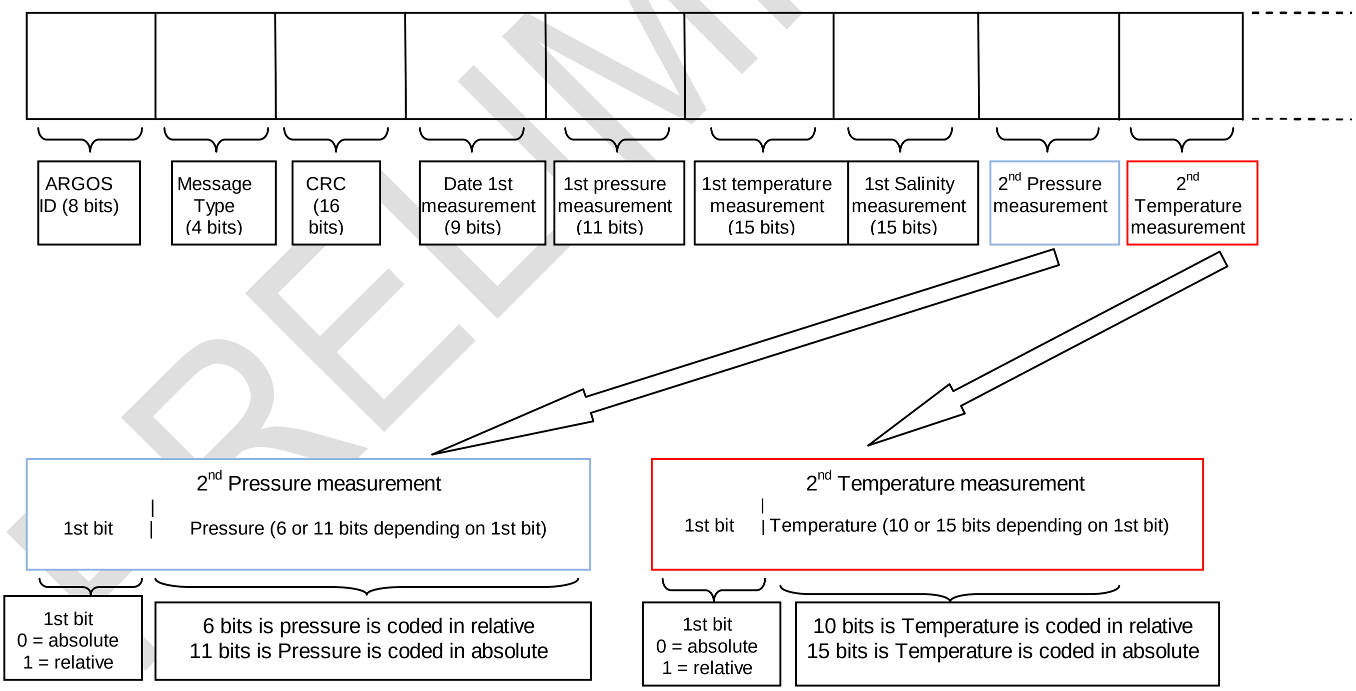


Figure 10 - Data compression priciple

Unused leaving bits are padded with zeros.

With this method, one message can contains from 5 CTD samples (if all fields are coded in absolute way, up to 7 samples, if most of the data are coded in relative way). Average is approx 6.5 CTD samples per message (Average based on complete profile messages transmission).

6.5 Descent profile CTD Message (type = 4)

Data	Format	Bit Number
28 bits ARGOS ID complement	8 bits	1 to 8
Message type (type = 0100)	4 bits	9 to 12
CRC	16 bits	13 to 28
Date of the first CTD measurement (1)	9 bits	29 to 37
First pressure measurement	11 bits	38 to 48
First temperature measurement	15 bits	49 to 63
First salinity measurement	15 bits	64 to 78
CTD measurements	178 bits	79 to 256

Table 6 - Descent profile CTD message

6.5.1 Cyclic Redundancy Check

The CRC type used is the CRC-CCITT of which the polynomial is $X^{16} + X^{12} + X^5 + 1$. The exclusive OR of the result is tested. The calculation of the CRC is carried out on the 256 bits of the message (the 248 bits of the message + 8 bits set to 0), the 16 bits (bits 5 to 20) reserved for the CRC being set to 0.

See section 11 ANNEX A: How to compute the CRC? Page 53 for details about CRC computing

6.5.2 CTD Triplets

The stored triplets are sent in the same order in which they were collected - that is, in order of decreasing depth for ascent profiles. Measurements within a triplet are sent in the sequence - pressure, temperature, salinity.

Only the first triplet of message is dated. It is dated relatively to the time of the first descent CTD data. We can approximate to descent profile start (given in technical message -type 1-, in the field number 7 : Descent start time). The least significant bit represents 1 minute.

Thus :

Real Date & Time of the first CTD measurement (in minutes) = Date of the first CTD measurement (1) + Descent start time with descent start time in minutes.

Subsequent triplets correspond to alternating data points in the profile (for example, number of measurements 1, 3, 5, 7, ...). Interleaving data points are sent in another message. This technique minimizes the impact of the loss of any one data message.

The CTD measurements starting from bit 79 (measurement numbers 3, 5, 7, etc.) are coded either as absolute measurements or as relative measurement. The first bit of each measurement is a format bit that indicates whether the reading is absolute (format bit = 0) or relative (format bit = 1).

See Section 6.4CTD Data compression principlepage 36 for details about compression principle

6.5.3 Pressure Coding

Depending upon the value of the first bit, it is followed by either 6 or 11 data bits. If the difference between the current pressure measurement Pn, and the previous pressure measurement Pn-1, is less than 63 dBar, the difference, |Pn - Pn-1| (always positive according to the decimation principle explained in chapter 6.3.2 page 35), is expressed in 6 bits. Otherwise, the pressure measurement is coded in 11 bits as an absolute measurement. Pressure is reported in the range 0 dBar to +2047 dBar with a resolution of 1 dBar.

Thus :

If format bit = 0 : Pn = [11 following bits data value]

If format bit = 1 : Pn = Pn-1 + [6 following bits data value]

and

Pressure (dBar) = Pn

6.5.4 Temperature Coding

Depending upon the value of the first bit, it is followed by either 10 or 15 data bits. If the difference between the current temperature measurement and the previous temperature measurement (Tn - Tn-1) is included in the closed interval [-0.923 °C, +0.100 °C], the difference -(Tn - Tn-1 - 0.1 °C) is coded into 10 bits.

The decoding will carry out the following operation: (- Ttransmitted + 0.1 °C)

Otherwise the measurement is absolutely coded in 15 bits with an offset of - 2 °C. The temperature is reported in the range -2°C to + 30.767°C, with a resolution of 0.001°C.

Thus:

if format bit = 0: Tn = [15 following bits data value]

if format bit =1: Tn = Tn-1 – {[10 following bits data value] – 100}

and

Temperature (°C) = (Tn / 1000) – 2

6.5.5 Salinity Coding

Depending upon the value of the first bit, it is followed by either 8 or 15 data bits. If the difference between the current salinity measurement and the previous salinity measurement (Sn - Sn-1) is included in the closed interval [-0.230 PSU ; +0.025 PSU], the difference -(Sn - Sn-1 -0.025PSU) is expressed in 8 bits.

The decoding will carry out the following operation: (- Stransmitted + 0.025PSU)

Otherwise, the measurement is absolutely coded in 15 bits with an offset of 10 PSU. Salinity is reported in the range of 10 PSU to 42.767 PSU with a resolution of 0.001 PSU.

Thus:

if format bit = 0: Sn = [15 following bits data value]

if format bit =1: Sn = Sn-1 – {[8 following bits data value] – 25}

and

Salinity (PSU) = (Sn / 1000) + 10

6.6 Submerged Drift CTD Message (type = 5)

Data	Format	Bit Number
28 bits ARGOS ID complement	8 bits	1 to 8
Message type (type = 0101)	4 bits	9 to 12
CRC	16 bits	13 to 28
Date of the first CTD measurement	6 bits	29 to 34
Time of first CTD measurement	5 bits	35 to 39
First pressure measurement	11 bits	40 to 50
First temperature measurement	15 bits	51 to 65
First salinity measurement	15 bits	66 to 80
CTD measurements	176 bits	81 to 256

Table 7 - Submerged Drift CTD Message

6.6.1 Cyclic Redundancy Check

CRC coding is as described above for the Ascent/Descent Profile CTD Message.

See section 11 ANNEX A: How to compute the CRC? Page 53 for details about CRC computing.

6.6.2 CTD Triplets

Only the first triplet is dated. The day number counts from the date at the beginning of the descent (for transmitted cycle that is also coded in technical message -type 1-, in field number 7). The hour number is the hour of the first measurement, relative to the descent start time. The least significant bit are 1 day (Date) & 1 hour (Time).

Thus :

Real Date & Time of the first CTD measurement (in minutes) = ROUND [(Date of the first CTD measurement * 24) +(Time of 1st CTD measurement * 60) + Descent start time]   with descent start time in minutes.

The stored triplets are sent in the same order in which they were collected. Measurements within a triplet are sent in the sequence - pressure, temperature, salinity.

Subsequent triplets correspond to alternating data points in the profile (for example, number of measurements 1,2, 3, 4, ...). Data are not interleaved as in descent or ascent message.

The CTD measurements starting from bit 81 (measurement numbers 2, 3, 4, etc.) are coded either as absolute measurements or as relative measurement. The first bit of each measurement is a format bit that indicates whether the reading is absolute (format bit = 0) or relative (format bit = 1).

See Section 6.4CTD Data compression principlepage 36 for details about compression principle.

6.6.3 Pressure Coding

If the difference between the current pressure sample, Pn , and the previous pressure sample, Pn-1 , is included in the closed interval [-31 dBar, +32 dBar], the coding of the difference, (Pn - Pn-1), is carried out into 6 bits two's-complement. Otherwise the pressure sample is coded in 11 bits as an absolute measurement. Pressure data is limited to the maximum value of 2,047 dBar.

Thus:

if format bit = 0: Pn = [11 following bits data value]

if format bit =1: Pn = Pn-1 + two's-complement of [6 following bits data value]

and

Pressure (dBar) = Pn

6.6.4 Temperature Coding

Depending upon the value of the first bit, it is followed by either 10 or 15 data bits. If the difference between the current temperature measurement and the previous temperature measurement (Tn - Tn-1) is included in the closed interval [-0.512 °C, +0.511 °C], the difference (Tn - Tn-1) is coded into 10 bits two's- complement. Otherwise the measurement is absolutely coded in 15 bits with an offset of - 2 °C. The temperature is reported in the range -2°C to + 30.767°C, with a resolution of 0.001°C.

Thus:

if format bit = 0: Tn = [15 following bits data value]

if format bit =1: Tn = Tn-1 + two's-complement of [10 following bits data value]

and

Temperature (°C) = (Tn / 1000) – 2

6.6.5 Salinity Coding

Depending upon the value of the first bit, it is followed by either 8 or 15 data bits. If the difference between the current salinity measurement and the previous salinity measurement (Cn - Cn-1) is included in the closed interval [-0.128 PSU ; +0.127 PSU], the difference (Cn-Cn-1) is expressed in 8 bits two's- complement. Otherwise, the measurement is absolutely coded in 15 bits with an offset of 10 PSU. Salinity is reported in the range of 10 PSU to 42.767 PSU with a resolution of 0.001 PSU.

Thus:

if format bit = 0: Sn = [15 following bits data value]

if format bit =1: Sn = Sn-1 + two's-complement of [8 following bits data value]

and

Salinity (PSU) = (Sn / 1000) + 10

6.7 Ascent profile CTD Message (type = 6)

Data	Format	Bit Number
28 bits ARGOS ID complement	8 bits	1 to 8
Message type (type = 0110)	4 bits	9 to 12
CRC	16 bits	13 to 28
Date of the first CTD measurement (2)	9 bits	29 to 37
First pressure measurement	11 bits	38 to 48
First temperature measurement	15 bits	49 to 63
First salinity measurement	15 bits	64 to 78
CTD measurements	178 bits	79 to 256

Table 8 - Ascent Profile CTD Message

6.7.1 Cyclic Redundancy Check

The CRC type used is the CRC-CCITT of which the polynomial is $X^{16} + X^{12} + X^5 + 1$. The exclusive OR of the result is tested. The calculation of the CRC is carried out on the 256 bits of the message (the 248 bits of the message + 8 bits set to 0), the 16 bits (bits 5 to 20) reserved for the CRC being set to 0.

See section 11 ANNEX A: How to compute the CRC? Page 53 for details about CRC computing.

6.7.2 CTD Triplets

The stored triplets are sent in the same order in which they were collected - that is, in order of decreasing depth for ascent profiles. Measurements within a triplet are sent in the sequence - pressure, temperature, salinity.

Only the first triplet is dated. It is dated relatively to the first ascent CTD data. We can approximate to the time of the ascent profile start time (Param #20 of tech Msg #1). The least significant bit represents 1 minute.

Thus :

Real Date & Time of the first CTD measurement (in minutes) = Date of the first CTD measurement (2) + Ascent start time with ascent start time in minutes.

Subsequent triplets correspond to alternating data points in the profile (for example, number of measurements 1, 3, 5, 7, ...). Interleaving data points are sent in another message. This technique minimizes the impact of the loss of any one data message.

The CTD measurements starting from bit 79 (measurement numbers 3, 5, 7, etc.) are coded either as absolute measurements or as relative measurement. The first bit of each measurement is a format bit that indicates whether the reading is absolute (format bit = 0) or relative (format bit = 1).

See Section 6.4CTD Data compression principlepage 36 for details about compression principle

6.7.3 Pressure Coding

Depending upon the value of the first bit, it is followed by either 6 or 11 data bits. If the difference between the current pressure measurement Pn, and the previous pressure measurement Pn-1, is less than 63 dBar, the difference, |Pn - Pn-1| (always positive according to the decimation principle explained in chapter 6.3.2 page 35), is expressed in 6 bits. Otherwise, the pressure measurement is coded in 11 bits as an absolute measurement. Pressure is reported in the range 0 dBar to +2047 dBar with a resolution of 1 dBar.

Thus:

if format bit = 0: Pn = [11 following bits data value]

if format bit =1: Pn = Pn-1 - [6 following bits data value]

and

Pressure (dBar) = Pn

6.7.4 Temperature Coding

Depending upon the value of the first bit, it is followed by either 10 or 15 data bits. If the difference between the current temperature measurement and the previous temperature measurement (Tn - Tn-1) is included in the closed interval [-0.100 °C, +0.923 °C], the difference (Tn - Tn-1 + 0.1 °C) is coded into 10 bits.
The decoding will carry out the following operation: (Ttransmitted - 0.1 °C)

Otherwise the measurement is absolutely coded in 15 bits with an offset of - 2 °C. The temperature is reported in the range -2°C to + 30.767°C, with a resolution of 0.001°C.

Thus:

if format bit = 0: Tn = [15 following bits data value]

if format bit =1: Tn = Tn-1 + {[10 following bits data value] – 100}

and

Temperature (°C) = (Tn / 1000) – 2

6.7.5 Salinity Coding

Depending upon the value of the first bit, it is followed by either 8 or 15 data bits. If the difference between the current salinity measurement and the previous salinity measurement (Sn - Sn-1) is included in the closed interval [-0.025 PSU ; 0.230 PSU], the difference (Sn - Sn-1 + 0.025PSU) is expressed in 8 bits.
The decoding will carry out the following operation: (Stransmitted - 0.025PSU).

Otherwise, the measurement is absolutely coded in 15 bits with an offset of 10 PSU. Salinity is reported in the range of 10 PSU to 42.767 PSU with a resolution of 0.001 PSU.

Thus:

if format bit = 0: Sn = [15 following bits data value]

if format bit =1: Sn = Sn-1 + {[8 following bits data value] – 25}

and

Salinity (PSU) = (Sn / 1000) + 10

6.8 Example of calculation based on CTD ascent frame (hexadecimal)

Hexadecimal frame received from CLS ARGOS :

fffe2ffxxxxxxx6acc61c27e68b9751b919f2ae817233355cbae121601d2bccc39d318e80000

with fffe2f : Argos frame header (common to all ARGOS Frame)

with f : Argos message length

with xxxxxxx : Hexadecimal ARGOS ID

Depending on method for Argos message receiving, these 3 previous fields could be already decoded by CLS ARGOS

with 6 : Message type (here : “Ascent Profile CTD message”)

with ACC6 : CRC

1st CTD Data Date and Hour : Day 0, Hour 0, minutes 56

CTD samples

P (dBar)	T (m°C)	S (mPSU)	
638	11404	33878	[a a a]
588	11285	33810	[r a a]
538	11109	33738	[r a a]
490	11142	33713	[r r r]
438	11419	33736	[r r r]
387	11624	33740	[r r r]

With [**r a a**], meaning that Pressure is **R**elatively coded, Temperature is **A**bsolutely coded, and Salinty is **A**bsolutelly coded.

First CTD sample of message is always absolutely coded, as it can be used for 2nd CTD sample decoding.

6.9 Technical Messages (type = 0 & 1)

For each complete set of CTD messages sent, both technical message are sent one and one-half times. Thus, for two complete sets of CTD messages sent, there will be three technical messages (average for complete transmission period).

	Data	Nb bits	Res.
	28 bits Argos ID Complement	8	
0	Type (=0)	4	
1	CRC	16	
	Cycle information		
2	Cycle Number	9	1 cycle
	Deployment		
3	External bladder state at deployment (0: float stay at surface, 1: heavy float at deployment)	1	
	Buoyancy reduction		
4	Real valve opening time at surface	8	10 s
5	additional valve actions at surface	9	
6	Grounding at Surface (0 : no grounding, 1 : grounding)	1	Y / N
	Descent to Parking Depth		
7	Nb of valve actions in descent to Parking Depth	5	
8	Nb of pump actions in descent to Parking Depth	5	
	Drift at Parking Depth		
9	Nb of entrance in Drift target range	3	
10	Nb of repositionning in Parking Stand-by	4	
11	Number of valve actions during drift at Parking Depth	5	
12	Number of pump actions during drift at Parking Depth	5	
	Descent to Profile Depth		
13	Nb of valve actions in descent to Profile Depth	5	
14	Nb of pump actions in descent to Profile Depth	5	
	Grounding		
15	1st Grounding Pressure	8	1 bar
16	1st Grounding day relative to cycle start	4	1 day
17	1st Grounding Hour	8	6 min
18	1st Grounding phase (*)	3	
19	Total Grounding number	3	
	Drift at Profile Depth		
20	Number of entrance in Profile target range	3	
21	Number of repositionning in Profile stand-by	3	
22	Number of valve actions during drift at Profile Depth	5	
23	Number of pump actions during drift at Profile Depth	5	
	Ascent Profile		
24	Number of pump actions in ascent	5	

25	Number of pump actions in ascent for float lift-up	5	
	Data information		
26	Number of descent CTD messages	5	
27	Number of drift CTD messages	5	
28	Number of ascent CTD messages	5	
29	Number of descent slices in shallow zone	7	
30	Number of descent slices in deep zone	8	
31	Number of CTD measurements in drift	8	
32	Number of ascent slices in shallow zone	7	
33	Number of ascent slices in deep zone	8	
	General Information		
34	Internal vacuum	3	5 mBar
35	Internal vacuum at Profile start	3	5 mBar
36	Battery voltage Drop at Pmax, Pump ON (With regards to Unom = 15.0 V, in dV)	7	0.1V
37	RTC Error	1	Y / N
38	CTD Error (0 : no error, 1 Time-Out, 2, incomplete or broken frame, 3 = fast pressure default)	2	
39	CTD default phase (*)	4	
40	Oxygen sensor status (0 : OK, 1 : Problem) (optional)	2	
41	Auto-test Flag (0 : Problem, 1 : OK)	1	
42	Last reset day : DD	5	1 day
43	MM	4	1 month
	Emergency ascent		
44	Number of emergency ascent	3	
45	1st emergency ascent Hour	8	6 min
46	1st emergency ascent Pressure (add to 200 Bars)	5	1 bar
47	Pump actions during emergency ascent	6	
48	1st emergency ascent day relative to Cycle start	4	1 day
	TOTAL	256	

Table 9 – First Technical Message type 0

(*) : see Section 6.9.6 page 47 for phase description

See section 12.2 Technical data page 55 for details about ARGO decoding.

	Data	nb bits	Res.
	28 bits ARGOS ID complement	8	
0	Type (=1)	4	
1	CRC	16	
2	Cycle number	9	1 cycle
3	Format code	11	
	Buoyancy reduction		
4	Cycle Start day : DD	5	
5	Cycle Start Month : MM	4	
6	Cycle Start Hour	11	1 min
	Descent to Parking Depth		
7	Descent Start Time	11	1 min
8	Float Stabilisation Time	8	6 min
9	End of descent time	11	1 min
10	1st Stabilisation Pressure	8	1 Bar
11	Max pressure in descent to Parking Depth	8	1 Bar
	Descent to Parking Depth		
12	Parking drift Start day	5	1 day
13	Min Pressure in Drift	11	1 dBar
14	Max Pressure in Drift	11	1 dBar
	Descent to Profile Depth		
15	Descent to Profile Depth Start time	11	1 min
16	Descent to Profile Depth Stop time	8	6 min
17	Max Pressure in descent Profile Depth	8	1 Bar
	Drift at Profile Depth		
18	Min Pressure in Drift at Profile Depth	8	1 Bar
19	Max Pressure in Drift at Profile Depth	8	1 Bar
	Ascent Profile		
20	Ascent Profile Start time	11	1 min
21	Ascent Profile Stop time	11	1 min
	General Information		
22	Float's internal Hours	5	1 h
23	Float's internal Minutes	6	1 min
24	Float's internal Seconds	6	1 sec
25	Float's internal Day	5	1 day
26	Pressure Sensor Offset	7	1 cBar
	Previous cycle transmission		
27	Transmission Start day : dd	5	1 day
28	Transmission Start hour : hh	8	6 min
29	Number of repetitions for each argos message	6	
30	0 to fill in message	2	
	TOTAL	**256**	

Table 10 - 2nd technical message (type 1)

- Tech. Param #6, #7, #8, #9, #15,#16, #20, #21 of tech. Msg #1 : all these time are expressed in minutes. Represent minutes in the day since midnight.

6.9.1 Descent Data

- Tech. Param #5 of tech. Msg #0 : Number of solenoid valve actions at the surface until the crossing of the 8 dBar threshold is an integer from 1 to 127 (modulo 128).
- Tech. Param #7 of tech. Msg #0 : Number of solenoid valve actions carried out to reach the target pressure after crossing the 8 dBar threshold.
- Tech. Param #4, #5 of tech. Msg #1 : Calendar day and month for buoyancy reduction start.
- Tech. Param #8 of tech. Msg #1 : Float stabilisation time after the crossing of the 8 dBar threshold is expressed in tenths of an hour.
- Tech. Param #10 of tech. Msg #1 : Float stabilisation pressure after crossing the 8 dBar threshold is coded in 8 bits with least significant bit = 1 bar.

6.9.2 Grounding data

- Tech. Param #15 to 18 of tech. Msg #0 : First grounding detected during the dive.

6.9.3 Drift Data

- Tech. Param #12 of tech. Msg #1 : Calendar day (day in the month) for Parking drift start.
- Tech. Param #13 & 14 of tech. Msg #1 : Minimum and maximum pressure in drift collected during the hydraulics measurements. Pressure is coded with least significant bit = 1dBar

6.9.4 Ascent Data

- Tech. Param #21 of tech. Msg #1 : Time at end of ascent is the time at the end of the pump action after surfacing. It is expressed in minutes.

6.9.5 Housekeeping Data

- Tech. Param #25 of tech. Msg #1 : Calendar day (day in the month) as message is transmitted.
- Tech. Param #26 of tech. Msg #1 : Pressure sensor offset is measured at the surface. Least significant bit = 1 cbar
  Range: -32 cbar to +31 cbar
- Tech. Param #27 of tech. Msg #1 : Calendar day (day in the month) for previous ARGOS transmission start.
- Tech. Param #34 of tech. Msg #0 : Internal pressure is measured at the end of the ascent and before the Mission start. Measurements are given in 25 mbar steps starting from 725 mbar and are coded in 3 bits:

000	#725 mbar
001	726 mbar to 750 mbar
010	751 mbar to 775 mbar
011	776 mbar to 800 mbar
100	801 mbar to 825 mbar
101	826 mbar to 850 mbar
110	851 mbar to 875 mbar
111	>875 mbar

- Tech. Param #35 of tech. Msg #0 : Internal pressure is measured at the beginning of the ascent (same coding method than Param #34 of tech. Msg #0
- Tech. Param #42, #43 of tech. Msg #0 : Calendar day and month for float power ON.

See section 12.2 Technical data page 55 for details about ARGO decoding.

6.9.6 *Phase description*

Phase number	Phase Name	Description
0	Pre-mission	Mission beginning
1	Restoffset	Float send command “restoffset” command to CTD SBE41 Sensor
2	Buoyancy reduction	Float descending phase at surface (up to PT specific threshold)
3	Descent to parking pressure	Float descend to Parking Pressure depth
4	Parking Drift	Float drift at Parking Depth
5	Descent to profile pressure	Float descend to Profile Depth
6	Drift at Profile Depth	Float drift at Profile Depth
7	Ascent Profile	Float ascend to the surface
8	Satellite transmission	Float transmit all sensor and technical packets
9	Auto-test	Float performs Initial auto-test (during deployment

Table 11 - Phase Number Description

6.10 Life Expiry Messages

Life expiry messages are transmitted when the float is drifting at the surface and has completed transmission of all data from the last cycle of the Mission. Life Expiry mode continues until the recovery of the float or depletion of the battery.
These transmissions - unlike other transmissions - occur at 100-sec intervals (“AC1”). The content of the life expiry messages is identical to the technical message type 0 & 1

6.11 Parameter Message (type = 2)

This message will be transmitted only during deployment phase : Initial ARGOS transmission period, depending on “AC6” value (Argos Command n° 6).

Data	nb bits	Res.
Argos ID complement	8	
Type (=0010)	4	
CRC	16	
Mission command		
MC0 - Total Number of Cycles	9	
MC1 - Number of cycle with “Cycle Period 1”	9	
MC2 - Cycle Period 1	10	Hour
MC3 - Cycle Period 2	10	Hour
MC4 - Reference Day	4	Relative day
MC5 - Estimated time at the surface	5	Hour
MC6 - Delay Before Mission	8	Min
MC7 - Descent Sampling Period	8	Sec
MC8 - Drift Sampling Period	8	Hour
MC9 - Ascent Sampling Period	8	Sec
MC10 - Drift Depth for “MC1” first cycles	11	dBar
MC11 - Profile Depth for “MC1” first cycles	11	dBar
MC12 - Drift Depth after “MC1” cycles are done	11	dBar
MC13 - Profile Depth after “MC1” cycles are done	11	dBar
MC14 - Threshold surface/Intermediate Pressure	11	dBar
MC15 - Threshold Intermediate /bottom Pressure	11	dBar
MC16 - Thickness of the surface slices	11	dBar
MC17 - Thickness of the intermediate slices	11	dBar
MC18 - Thickness of the bottom slices	11	dBar
MC19 - Iridium End Of life period (UNUSED)	10	Min
MC20 - 2nd Iridium Session Wait Period (UNUSED)	8	Min
MC21 - Grounding mode (0= Shift, 1 : Stay grounded)	1	
MC22 - Grounding switch Pressure	11	dBar
MC23 - Delay at surface if grounding at surface	8	Min
MC24 - Optode type (0 : none, 1 : 4330, 2 : 3830)	3	
Zero to fill in message	9	
TOTAL	**256**	

Table 12 - Parameter message description (type 2)

See section 12.3 Parameter data page 59 for details about ARGO decoding.

7 SPECIFICATIONS

- Storage

Temperature range.. -20°C to +50°C
Storage time before expiry ....up to 1 year

- Operational

Temperature range... 0°C to +40°C
Pressure at drift depth .... 40 bar to 200 bar
Depth maintenance accuracy .... ± 3 bar typical (adjustable)
Survival at sea ....up to 5 years
Maximum number of cycles.................up to 255 cycles (ARVOR) or up to 160 cycles (ARVOR-L)

- Mechanical

Length
with antenna ....#200 cm
Diameter
casing ....11 cm
damping disk .... 25 cm
Weight..20kg(ARVOR) or 18kg (ARVOR-L)
Material... anodized aluminum casing

- Sensors

Salinity
range...................... .... 10 to 42 PSU
initial accuracy .... ± 0.005 PSU
resolution.. 0.001 PSU
Temperature
range... .... -3°C to +32°C
initial accuracy ....± 0.002°C
resolution..0.001°C
Pressure
range... .... 0 bar to 2500 dBar
initial accuracy .... ± 2.4 dBar*
resolution..0.1 dBar
Offset adjusted when surfacing

(*) offset has to be adjusted at each surfacing

8 ARVOR OPERATING PRINCIPLE

Movement of the float through its profile is accomplished by a pump and valve system. The pump transfers oil from the inner reservoir to the outer bladder. Oil moves back to the reservoir when the valve is opened- -driven by the difference between the float's internal and external pressures.
The float's speed of ascent oscillates. This oscillation is due to the way in which the float's controller regulates its speed. The controller, using depth measurements from the float's pressure sensor, calculates the change in depth over a set period of time. With this information, the controller determines the float's speed.

When ascending, if the calculated speed is lower than desired, the pump is activated for about 10 seconds, pumping oil into the outer bladder. This produces an increase in buoyancy, which increases the speed of ascent.
As the float rises to shallower depths, its buoyancy decreases, causing the ascent speed to also decrease. When the calculated speed is too low, the pump is activated again.

This cycle repeats until the float reaches the surface.
The same regulating method is used to control the float's descent speed, by opening the valve and allowing oil to flow from the external bladder to the internal reservoir.

Why does ARVOR's speed decrease as it ascends?
The buoyancy of a float is determined principally by its mass and its volume, but another factor, hull compressibility, also plays an important role. As ARVOR ascends, the decrease in water density reduces the float's buoyancy. At the same time, the decrease in water pressure causes ARVOR's hull to expand, which increases the float's buoyancy. The two effects tend to counteract each other.
Because ARVOR's compressibility is actually less than that of sea water, the decrease in buoyancy due to decreasing water density is greater than the increase in buoyancy due to hull expansion. This causes ARVOR's speed of ascent to decrease as it rises in the water column.
Conversely, as the float descends, the increasing water density increases the buoyancy more than the decreasing buoyancy from hull compression. This causes ARVOR's speed of descent to slow as it goes deeper.

To reduce the probability of contact with ships, ARVOR's target speed during the initial stage of descent is high at shallow depths. This minimizes the time during which the float is at risk of damage.
To slow the float's descent, its controller is programmed with a series of depths at which the descent speed is halved until it reaches the target depth.

9 LITHIUM BATTERY

All batteries, both lithium and other with chemical elements, contain large quantities of stored energy. This is, of course, what makes them useful, but it also makes them potentially hazardous.

If correctly handled, neither alkaline nor lithium batteries present any risk to humans or the environment. Improper handling of these batteries presents potential risks to humans, but does not present an environmental risk.

The energy stored in a battery cell is stored in chemical form. Most batteries contain corrosive chemicals. These chemicals can be released if the cells are mishandled. Mishandling includes:

- short-circuiting the cells;
- (re)charging the cells;
- puncturing the cell enclosure with a sharp object;
- exposing the cell to high temperatures.

WARNING: BOTH ALKALINE AND LITHIUM BATTERIES MAY EXPLODE, PYROLIZE OR VENT IF MIS-HANDLED. DO NOT DISASSEMBLE, PUNCTURE, CRUSH, SHORT-CIRCUIT, (RE)CHARGE OR INCINERATE THE CELLS. DO NOT EXPOSE CELLS TO HIGH TEMPERATURES.

The lithium thionyl chloride cells used in ARVOR floats incorporate sealed steel containers, warning labels and venting systems to guard against accidental release of their contents.

WARNING: IF A BATTERY SPILLS ITS CONTENTS DUE TO MISHANDLING, THE RELEASED CHEMICALS AND THEIR REACTION PRODUCTS INCLUDE CAUSTIC AND ACIDIC MATERIALS, SUCH AS HYDROCHLORIC ACID (HCL) IN THE CASE OF LITHIUM THIONYL CHLORIDE BATTERIES, AND POTASSIUM HYDROXIDE (KOH) IN THE CASE OF ALKALINE BATTERIES. THESE CHEMICALS CAN CAUSE EYE AND NOSE IRRITATION AND BURNS TO EXPOSED FLESH.

The hazard presented by these chemicals is comparable to that presented by common domestic cleaning materials like bleach, muriatic acid or oven cleaner.

Inevitably, the battery contents will eventually be released into the environment, regardless of whether the cells are deliberately dismantled or simply disintegrate due to the forces of nature. Because of their highly reactive nature, battery materials disintegrate rapidly when released into the environment. They pose no long-term environmental threat. There are no heavy metals or chronic toxins in ARVOR's lithium cells. Indeed, a recommended safe disposal method for thionyl chloride lithium cells is to crush them and dilute them in sufficient quantities of water.

Discharged batteries pose a greatly reduced threat, as the process of discharging them consumes the corrosive chemicals contained in them.

In summary, ARVOR's lithium battery poses no significant or long-term environmental threats. Any threats that they do present, are short-term threats to the safety of persons mishandling the cells. These safety threats are similar to those of other common household-use materials. These threats are reduced when the cells are discharged - and exist only if the cells are mishandled in extreme ways. These threats are the same as those presented by the alkaline cells widely used by consumers.

10 GLOSSARY

AC, MC
Argos and Mission Commands set

BT
Bluetooth

COM1, COM2.
Serial communication ports.

CPU
Central Processing Unit. In the context of ARVOR, this term denotes the board that ensures the running and control of the system.

CTD
Celerity (for salinity), Temperature and Depth

dBar.
1/10 bar = 1 decibar Unit of pressure used for ARVOR. It roughly corresponds to a depth of 1m.

IFREMER
Institut Français pour la Recherche et l'Exploitation de la MER (French Institute for the Research and the Exploitation of the Sea).

MC
Measurement code. Unique number assigned to each element of the Argo Trajectory file to code the exact meaning of the stored information.

Mission
The portion of ARVOR's life that consists of a number of repeating cycles of descent, submerged drift, ascent and data transmission.

PC
Personal Computer; IBM-PC compatible.

PTT
Platform Terminal Transmitter (Argos transmission electronics).

RS232
Widely recognized standard for the implementation of a serial data communication link.

TBD
To Be Defined. This information is not available yet.

Triplet
Set of four measurements (Salinity, Temperature and Depth) all taken at the same time.

Two's-complement
A system for representation of negative numbers in binary notation. The decimal equivalent of a two's- complement binary number is computed in the same way as for an unsigned number, except that the weight of the most significant bit is -2n-1 instead of +2n-1.

VT52, VT100
Video Terminal, type 52 or 100
Computer terminals developed by Digital Equipment Corporation (DEC). They are considered standard in the field.

11 ANNEX A: HOW TO COMPUTE THE CRC?

You can find behind an example of a Matlab implementation of the CRC processing for Arvor Argos floats.

Remember that the transmitted CRC is provided on bits 5 to 20 of the Argos message.

You first have to store this “transmitted_CRC” value and to set the corresponding 16 bits (bits 5 to 20) of the Argos message to 0.

You can then compute the CRC of this “received Argos message” using the following procedure.

Finally you have to compare the “computed_CRC” (o_computedCrc in the Matlab code) and the “transmitted_CRC” to check if the Argos message contents has been impacted by transmission errors.

```
% ------------------------------------------------------------------------------
% Compute PROVOR CRC for given data.
%
% SYNTAX :
%  [o_computedCrc] = compute_crc_prv(a_sensor)
%
% INPUT PARAMETERS :
%   a_sensor : data to check
%
% OUTPUT PARAMETERS :
%   o_computedCrc : computed CRC
%
% EXAMPLES :
%
% SEE ALSO :
% AUTHORS  : Jean-Philippe Rannou (Altran)(jean-philippe.rannou@altran.com)
% ------------------------------------------------------------------------------
% RELEASES :
%   01/02/2010 - RNU - creation
% ------------------------------------------------------------------------------
function [o_computedCrc] = compute_crc_prv(a_sensor)

% add 8 bits set to 0 at the end of the data
if (length(a_sensor) == 31)
   a_sensor(end+1) = 0;
end

% compute CRC
poly = uint16(hex2dec('1021'));
crc = uint16(0);
for idByte = 1:length(a_sensor)
   crc = bitxor(crc, bitshift(uint16(a_sensor(idByte)), 8));
   for idBit = 1:8
      droppedBit = bitget(crc, 16);
      crc = bitshift(crc, 1);
      if (droppedBit == 1)
         crc = bitxor(crc, poly);
      end
   end
end

o_computedCrc = crc;

return;
```

12 ANNEX B: ACCESS TO DECODED DATA OF ARGO FLOATS

If the float has been deployed within the framework of the Argo project (http://www.argo.ucsd.edu/), the decoded data are available in one of the 4 NetCDF files (META, PROF, TRAJ, TECH) used by the Argo data management to store and diffuse the information (see http://www.argodatamgt.org/Documentation for details).

In the following paragraphs, we describe where each decoded data can be found.

12.1 Sensor measurements

12.1.1 Argo parameter names

The CTD measurements are stored in the Argo files with a unique variable name.

Sensor parameter	Argo variable name
Pressure	PRES
Temperature	TEMP
Salinity	PSAL

12.1.2 Descent profile CTD measurements

Decoded data	Argo file	Argo Variable
CTD profile measurements	PROF	PRES, TEMP, PSAL
Dated levels of the profile	TRAJ	N_MEASUREMENT variables with MC = 190

12.1.3 Submerged drift CTD measurements

Decoded data	Argo file	Argo Variable
CTD drift measurements	TRAJ	N_MEASUREMENT variables with MC = 290

12.1.4 Ascent profile CTD measurements

Decoded data	Argo file	Argo Variable
CTD profile measurements	PROF	PRES, TEMP, PSAL
Dated levels of the profile	TRAJ	N_MEASUREMENT variables with MC = 590

12.2 Technical data

12.2.1 Technical message type 0

	Argo file	Argo variable	Parameter name or Measurement Code (MC)
0	-	-	-
1	-	-	-
Cycle information			
2	TECH	CYCLE_NUMBER	
	TRAJ	CYCLE_NUMBER(N_MEASUREMENT)	
	TRAJ	CYCLE_NUMBER_INDEX(N_CYCLE)	
Deployment			
3	TBD	TBD	TBD
Buoyancy reduction			
4	TBD	TBD	TBD
5	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_ValveActionsAtSurfaceDuringDescent_COUNT
6	TBD	TBD	TBD
Descent to Parking Depth			
7	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_ValveActionsDuringDescentToPark_COUNT
8	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_PumpActionsDuringDescentToPark_COUNT
Drift at Parking Depth			
9	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_DescentToParkEntriesInParkMargin_COUNT
10	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_RepositionsDuringPark_COUNT
11	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_ValveActionsDuringPark_COUNT
12	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_PumpActionsDuringPark_COUNT
Descent to Profile Depth			
13	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_ValveActionsDuringDescentToProfile_COUNT
14	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_PumpActionsDuringDescentToProfile_COUNT
Grounding			
15	TRAJ	N_MEASUREMENT variables	MC = 901
16			
17			
18	-	-	-
19	TBD	TBD	TBD
Drift at Profile Depth			
20	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_DescentToProfileEntriesInProfileMargin_COUNT
21	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_RepositionsAtProfileDepth_COUNT
22	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_ValveActionsDuringProfileDrift_COUNT
23	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_PumpActionsDuringProfileDrift_COUNT
Ascent Profile			
24	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_PumpActionsDuringAscentToSurface_COUNT
25	TBD	TBD	TBD
Data information			
26	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_FramesEmittedOnDescendingProfile_COUNT
27	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_FramesEmittedOnPark_COUNT
28	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_FramesEmittedOnAscendingProfile_COUNT
29	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_DescendingProfileReductionUpperPart_COUNT
30	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_DescendingProfileReductionLowerPart_COUNT

31	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_ParkCTDSamplesInternal_COUNT
32	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_AscendingProfileReductionUpperPart_COUNT
33	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_AscendingProfileReductionLowerPart_COUNT
General Information			
34	TECH	TECHNICAL_PARAMETER_VALUE	PRESSURE_InternalVacuumAtSurface_mBAR
35	TBD	TBD	TBD
36	TECH	TECHNICAL_PARAMETER_VALUE	VOLTAGE_BatteryPumpStartProfile_volts
37	TECH	TECHNICAL_PARAMETER_VALUE	FLAG_RTCStatus_LOGICAL
38	TBD	TBD	TBD
39	TBD	TBD	TBD
40	UNUSED	UNUSED	UNUSED
41	TBD	TBD	TBD
42	TBD	TBD	TBD
43	TBD	TBD	TBD
Emergency ascent			
44	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_EmergencyAscents_COUNT
45	TECH	TECHNICAL_PARAMETER_VALUE	CLOCK_TimeOfFirstEmergencyAscent_HHMM
46	TECH	TECHNICAL_PARAMETER_VALUE	PRES_FirstEmergencyAscent_DBAR
47	TECH	TECHNICAL_PARAMETER_VALUE	NUMBER_PumpActionsOnFirstEmergencyAscent_COUNT
48	TECH	TECHNICAL_PARAMETER_VALUE	CLOCK_TimeOfFirstEmergencyAscent_floatDAY

12.2.2 Technical message type 1

	Argo file	Argo variable	Parameter name or Measurement Code (MC)
0	-	-	-
1	-	-	-
2	TECH	CYCLE_NUMBER	
	TRAJ	CYCLE_NUMBER(N_MEASUREMENT)	
	TRAJ	CYCLE_NUMBER_INDEX(N_CYCLE)	
3	TBD	TBD	TBD
Buoyancy reduction			
4 5 6	TECH	TECHNICAL_PARAMETER_VALUE	CLOCK_StartBuoyancyReduction_YYYYMMDDHHMMSS
Descent to Parking Depth			
7	TRAJ	N_MEASUREMENT variables	MC = 100
	TRAJ	JULD_DESCENT_START	
8	TECH	TECHNICAL_PARAMETER_VALUE	CLOCK_InitialStabilizationDuringDescentToPark_HHMM
	TRAJ	N_MEASUREMENT variables	MC = 150
	TRAJ	JULD_FIRST_STABILIZATION	
9	TRAJ	N_MEASUREMENT variables	MC = 250
	TRAJ	JULD_PARK_START	
10	TECH	TECHNICAL_PARAMETER_VALUE	PRES_InitialStabilizationDuringDescentToPark_dBar
	TRAJ	N_MEASUREMENT variables	MC = 150
11	TRAJ	N_MEASUREMENT variables	MC = 198
Descent to Parking Depth			
12	TBD	TBD	TBD
13	TECH	TECHNICAL_PARAMETER_VALUE	PRES_ParkMinimum_dBar
	TRAJ	N_MEASUREMENT variables	MC = 297
14	TECH	TECHNICAL_PARAMETER_VALUE	PRES_ParkMaximum_dBar
	TRAJ	N_MEASUREMENT variables	MC = 298
Descent to Profile Depth			
15	TRAJ	N_MEASUREMENT variables	MC = 300
	TRAJ	JULD_PARK_END	
16	TRAJ	N_MEASUREMENT variables	MC = 450
	TRAJ	JULD_DEEP_PARK_START	
17	TECH	TECHNICAL_PARAMETER_VALUE	PRES_DescentToProfileMaxPressure_dBar
	TRAJ	N_MEASUREMENT variables	MC = 398
Drift at Profile Depth			
18	TRAJ	N_MEASUREMENT variables	MC = 497
19	TRAJ	N_MEASUREMENT variables	MC = 498
Ascent Profile			
20	TRAJ	N_MEASUREMENT variables	MC = 500
	TRAJ	JULD_ASCENT_START	
21	TRAJ	N_MEASUREMENT variables	MC = 600
	TRAJ	JULD_ASCENT_END	
General Information			
22	TECH	TECHNICAL_PARAMETER_VALUE	CLOCK_FloatTime_HHMMSS

23			
24			
25	TBD	TBD	TBD
26	TECH	TECHNICAL_PARAMETER_VALUE	PRES_SurfaceOffsetBeforeReset_1cBarResolution_dBar
Previous cycle transmission			
27	TRAJ	N_MEASUREMENT variables	MC = 700
28	TRAJ	JULD_TRANSMISSION_START	
29	TBD	TBD	TBD

12.3 Parameter data

12.3.1 Mission commands

	Argo file	Argo variable	Parameter name
		Mission commands	
MC0	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_MaxCycles_NUMBER
MC1	-	-	-
MC2	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_CycleTime_days
MC3	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_CycleTime_days
MC4	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_FloatReferenceDay_FloatDay
MC5	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_ClockAscentStart_HH
MC6	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_DelayBeforeMissionStart_minutes
MC7	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_DescentToParkPresSamplingTime_seconds
MC8	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_ParkSamplingPeriod_hours
MC9	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_AscentSamplingPeriod_seconds
MC10	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_ParkPressure_dBar
MC11	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_ProfilePressure_dBar
MC12	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_ParkPressure_dBar
MC13	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_ProfilePressure_dBar
MC14	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_PressureThresholdDataReductionShallowToIntermediate_dBar
MC15	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_PressureThresholdDataReductionIntermediateToDeep_dBar
MC16	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_ProfileSurfaceSlicesThickness_dBar
MC17	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_ProfileIntermediateSlicesThickness_dBar
MC18	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_ProfileBottomSlicesThickness_dBar
MC19	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_TransmissionPeriodEndOfLife_seconds
MC20	-	-	-
MC21	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_GroundingMode_LOGICAL
MC22	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_GroundingModePresAdjustment_dBar
MC23	TBD	TBD	TBD
MC24	-	-	-

12.3.2 Argos commands

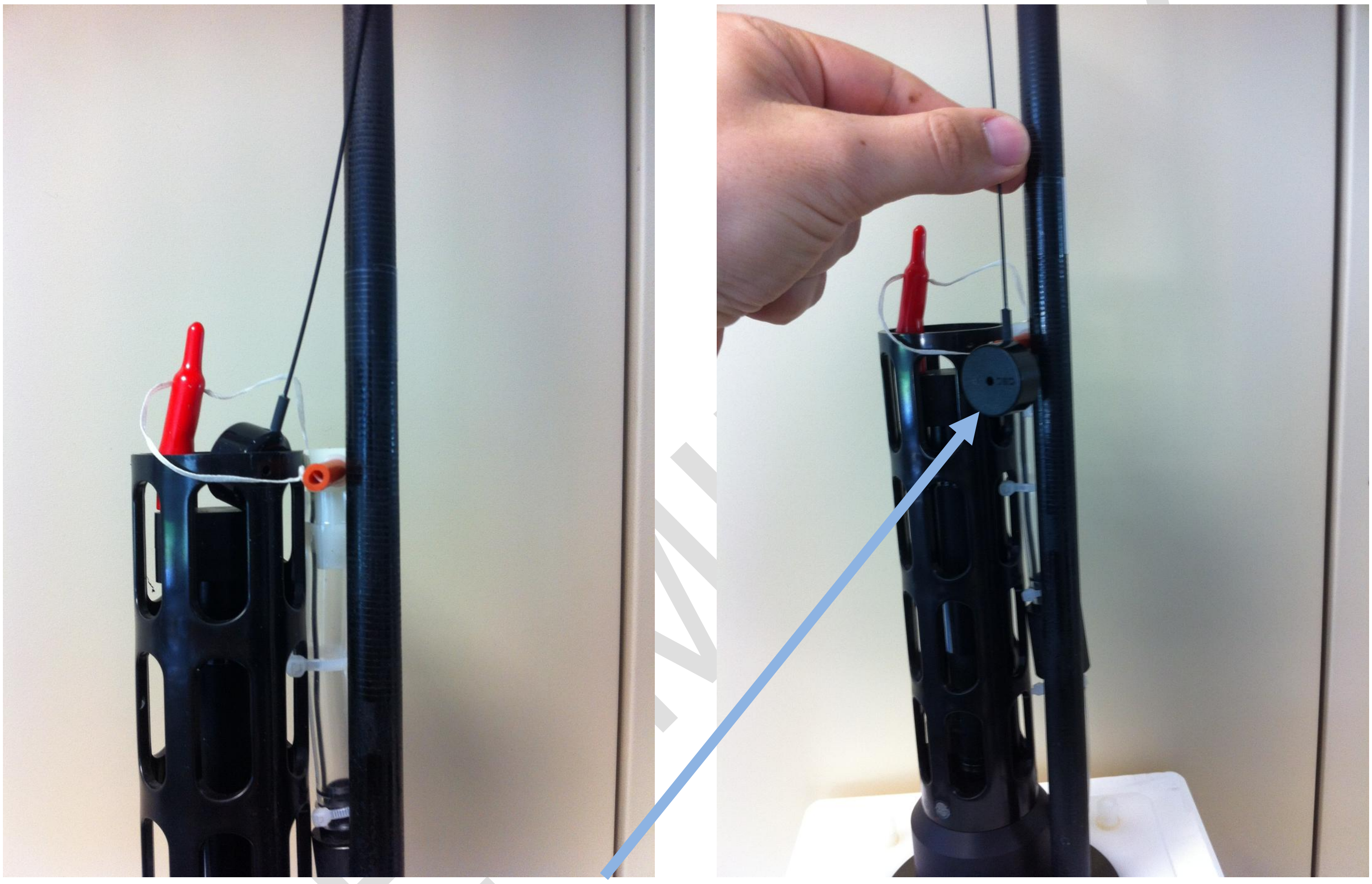
	Argo file	Argo variable	Parameter name
Argos commands			
AC0	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_TransmissionRepetitionPeriod_seconds
AC1	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_TransmissionPeriodEndOfLife_seconds
AC2	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_TelemetryRetransmission_COUNT
AC3	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_TransmissionMinTime_hours
AC4	-	-	-
AC5	META	PTT	
AC6	META	LAUNCH_CONFIG_PARAMETER_VALUE CONFIG_PARAMETER_VALUE	CONFIG_MissionPreludeTime_hours
AC7	META	TRANS_FREQUENCY	

12.3.3 Technical commands

TBD

13 ANNEX C : ARGOS BEEPER POSITIONNING

During Initial ARGOS transmission, place Argos beeper close to Argos antenna, to check transmission. Argos transmission period depends on float parameter, but is typically 100 seconds during test phase.



ARGOS Beeper position (closed to CTD sensor protection top part)

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